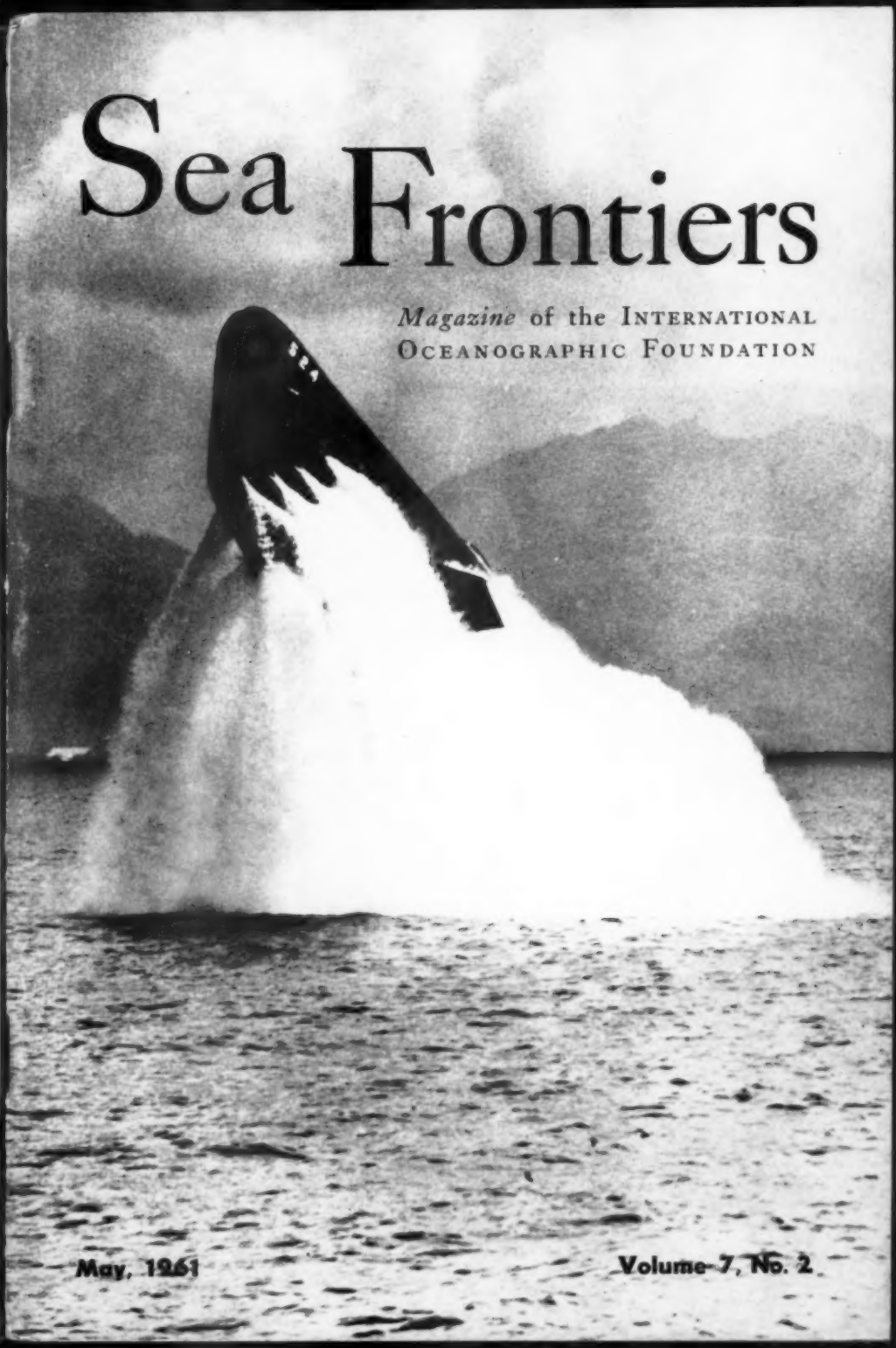
Sea Frontiers

Magazine of the INTERNATIONAL OCEANOGRAPHIC FOUNDATION



May, 1961 Volume 7, No. 2

MONEY MAY NOT, *but oysters do grow on trees in the tropical seas! Low tide along the edges of the Shark River, in Everglades National Park, Florida, discloses clusters of small oysters clinging to the exposed root branches of the red mangrove. (Walter B. Courtenay, Jr.)*

FRONT COVER. *The* USS Pickerel *executes a "battle surface," rising from a 48-degree angle during training exercises off Oahu, Hawaii. Such maneuvers would not be possible without scientific research. Expanded studies of the sea, advocated in the President's recent messages to the Congress, are of vital importance to the defense of the Free World. (U. S. Navy)*

BACK COVER. *As the world's population explosion continues, more and more nations will have to turn to the relatively neglected resources of the sea for many necessities, particularly food. Here fishermen in Indonesia prepare their catch for sale in a local marketplace. (UNESCO)*

SEA FRONTIERS

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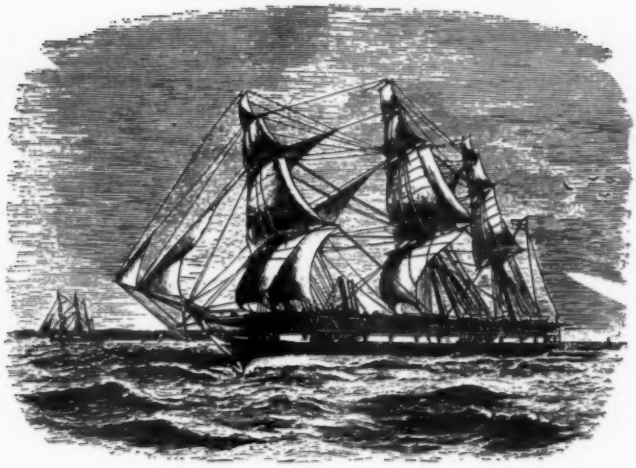

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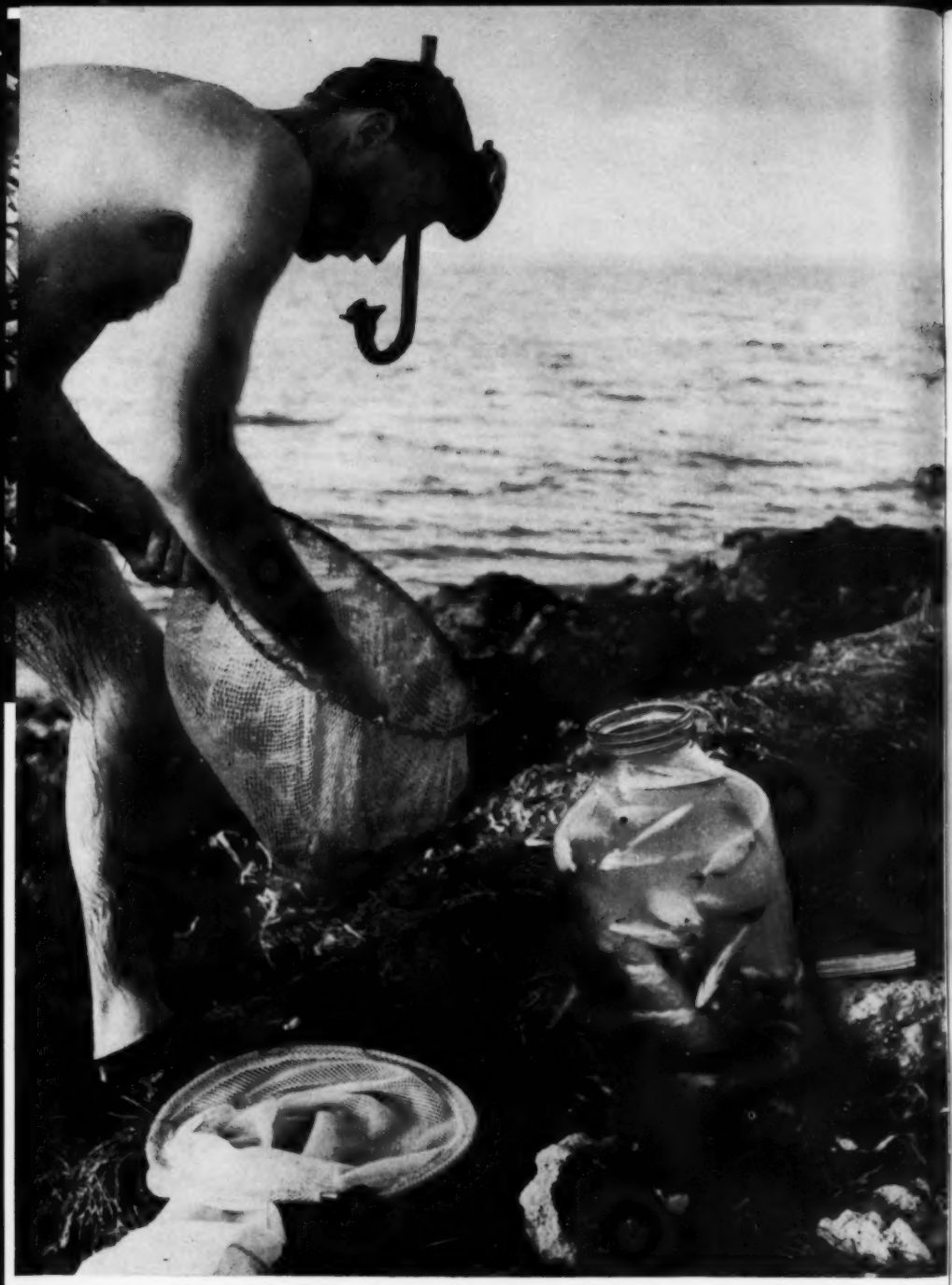


A Matter of Survival

AT LONG LAST oceanography in the United States is coming into its own. For many years private research institutions, financed largely with private capital and contributions, have waged an uphill fight, trying to learn more about the vast and little explored watery domain which nearly surrounds the United States and covers three-quarters of the earth.

Yet despite valiant efforts of American scientists and many others operating through out the world, only a mere fraction of the ocean's bottom and the life of the seas has been *scientifically* studied, and most of this research has been done along the continental shelves and adjacent areas.

"Just On the Threshold"

President Kennedy's budget message, recognizing the huge proportions and the urgency of the situation, has asked the Congress to double the amount of money the U.S. government spends in research on "the sea around us."

"We are just on the threshold of our knowledge of the oceans," Mr. Kennedy declared in an accompanying letter. "Knowledge of the oceans is more than a matter of curiosity. Our very survival may hinge upon it."

Role For Private Industry, Too

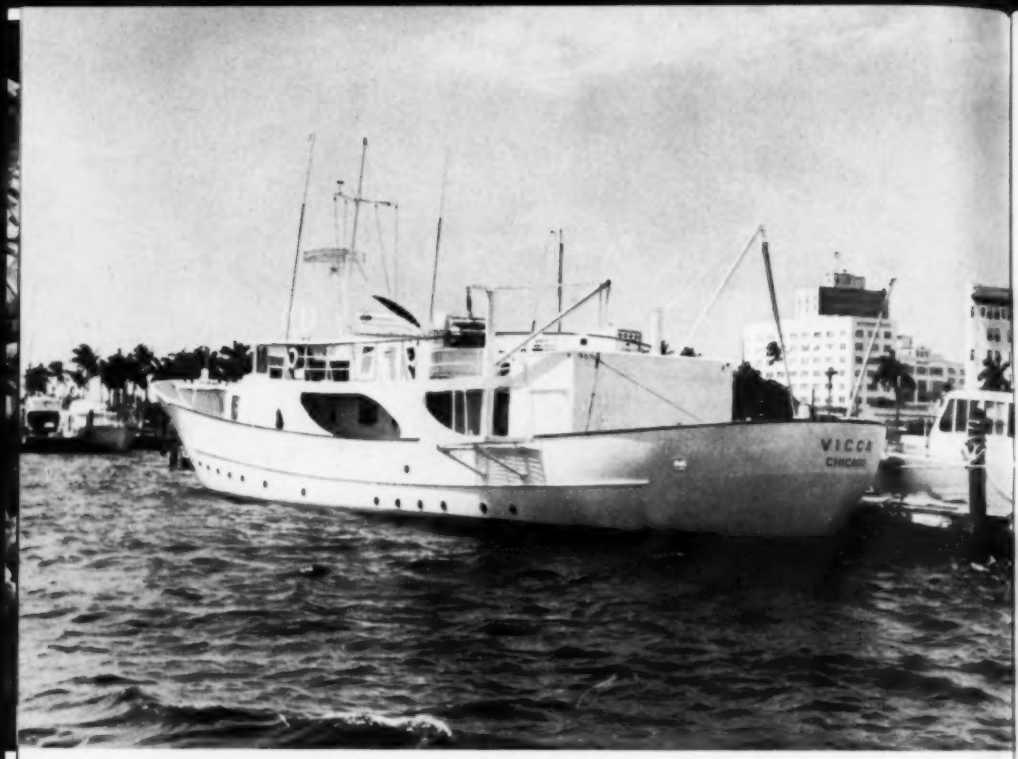
Private industry and foundations will continue to make contributions to specific oceanic research projects. But it is generally recognized that exploration of the major unknowns of Neptune's realm is much too involved and too costly to be undertaken by any single corporation or scientific institution, or even a grouping of them.

President Kennedy has taken action with a request for $97,501,000 in Federal funds for various new ventures in oceanography, ranging from the development of the sea's almost limitless food and mineral resources, to more accurate weather forecasting, the building of special marine research vessels, as well as the gathering of vital facts needed by the Navy in underseas operations and in the detection of enemy submarines.

One-Third Cost of Battleship

If, after having just paid your income tax, the sum asked of the Congress for the entire study of the oceans seems to be a bit large, remember it is no more than a third

TO MEET THE NEEDS OF *physical oceanography, the new effort on the part of the government must not overlook marine biology and research into the living creatures of the sea. Even in shallow coastal waters, much field work remains to be done. Here a skindiving scientist dumps specimens of reef fishes, collected off the Florida keys, into a jar of preservative. These will be taken back to the laboratory for examination as a preliminary to modern ecological studies. In today's oceanic research, by way of contrast, at least five scientists and technicians are required ashore for each scientist doing work at sea. (Institute of Marine Science, University of Miami)*



HOW PRIVATE INDUSTRY *is cooperating with science. Through a cooperative arrangement between the Marine Laboratory, Institute of Marine Sciences of the University of Miami, and the Velsicol Chemical Corporation, of Chicago, the* M/V Vicca *will be made available for studies of the least known life in the sea—the bacteria and fungi. Mounted on the aft deck of the* Vicca *is a unique portable oceanographic laboratory, weighing 6,000 pounds. When the* Vicca *is needed for other than scientific cruises, this "research capsule" can be swung from shipboard to its own especially designed trailer ashore until the next trip. (Mort Kaye Studios, Palm Beach)*

of the price we once paid for a single battleship, and trivial compared to the nearly three *billion* dollars now being expended for rockets, missiles, and space exploration.

What are some of the principal elements of this marine "survival program," America's first national effort in oceanography? Basically it covers seven elements: (1) Research ship construction; (2) shore laboratories and a data center; (3) basic and applied research; (4) training of oceanographers; (5) ocean surveys; (6) international cooperation, and (7) enlargement of the functions of the Coast Guard and the vessels of the U.S. Coast and Geodetic Survey.

Ten Oceanic Vessels

One of the most welcome and necessary features is a special allotment of $37 million for new ship construction, an increase of $23 million over the amount previously requested. This will provide for ten fully-equip-

ped oceanographic vessels. Two will replace existing ships; the others will be used to meet needs which have long existed in Federal agencies and in oceanographic institutions conducting marine research and exploration of the sea.

Data Center Most Important

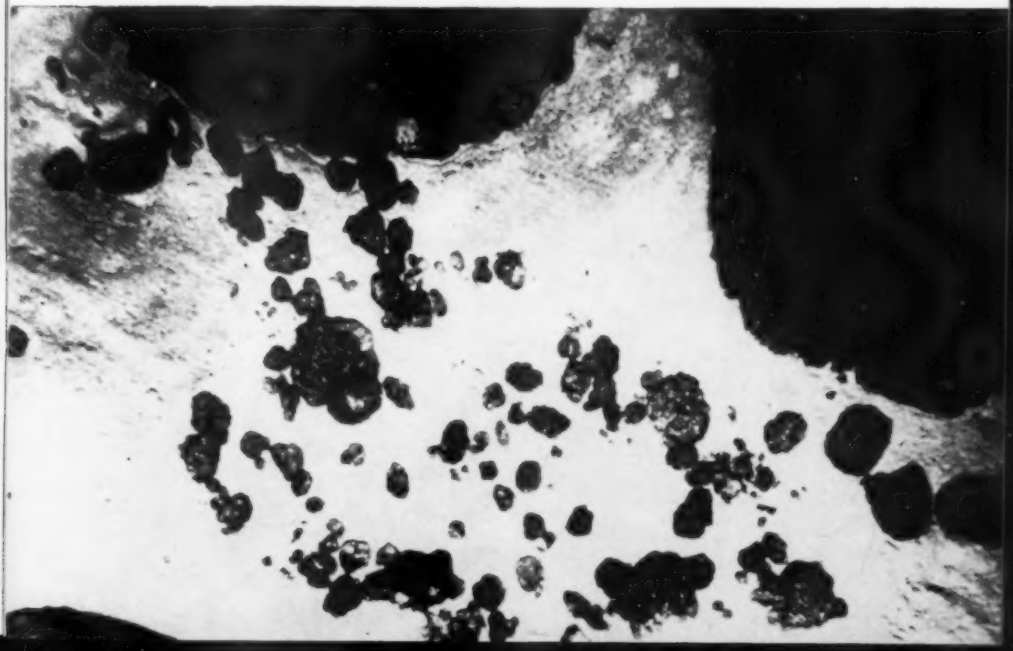
In modern oceanic research, about five scientists and technicians are required ashore for each scientist aboard ship. Laboratory space has long been urgently needed for analysis and interpretation of data obtained at sea, and to train new oceanographers. The new program calls for $10 million worth of laboratories and wharfside facilities. A most important new unit will be a National Oceanographic Data Center, which will collect and make available to the scientific community marine data obtained from every part of the world.

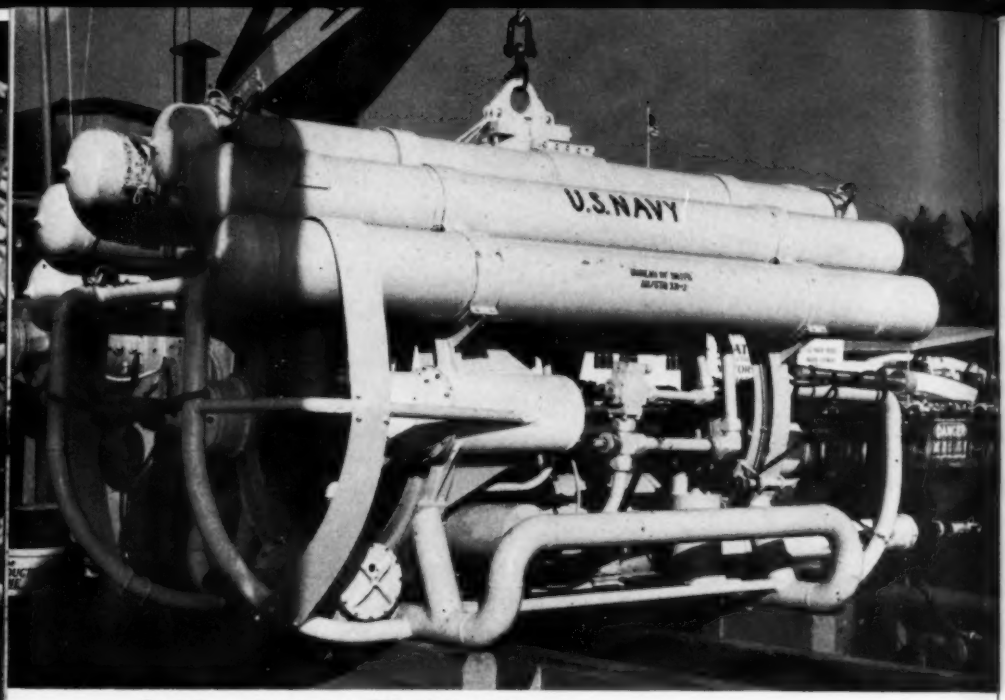
Studying "Inner Space"

Ships and shore facilities are essential tools of marine scientific research, but it is the research itself that will yield new knowledge of earth's "inner space," and reveal new uses of the sea and its products. The proposed program includes $41 million for this purpose.

Basic research, the cornerstone of marine exploration, depends upon the concentrated effort of individual scientists, working in laboratories and, more recently, at sea as well. As the readers of *Sea Frontiers* for the past

MANGANESE NODULES, *resting on the calcareous ooze of the ocean floor, testify to the vast untapped resources of the sea, not only in sea water itself but also in solid form. Such nodules are not formed like land ores, but are made up of materials which have washed into the sea in ages past and have adhered to pieces of clay, pumice, volcanic glass, or even shark's teeth or bone. But before man can mine this wealth, huge engineering problems must be solved. (U. S. Navy)*





LATEST IN UNDERSEAS TV. *A fantastic arrangement of tanks, tubes and piping, this strange contraption is a self-propelled, remote controlled, television vehicle used in underwater salvage and exploration. The tanks are filled with air to give the device buoyancy. (Jerry Greenberg)*

six years are aware, such investigations should embrace all aspects of the marine environment — motion and composition of ocean waters, the evolution and distribution of marine plants and animals, the shape and composition of the ocean bottom, and such mysteries as underwater sound, thermoclines, "deep scattering layers," and the effects of dumping atomic wastes (See "Ten Critical Years," *Sea Frontiers,* May, 1959).

Wanted: More Oceanographers

In recent years only a mere handful of fully-trained oceanographers have been granted degrees in the United States, perhaps because oceanography is a comparatively new and very specialized science. Russia meanwhile has launched an aggressive oceanographic training program, including cruises at sea for neophytes on a large fleet of new oceanic research ships, including a research submarine.

From the long-range point of view, the most vital phase of the proposed oceanographic program is the training of young scientists, technicians, navigators, and others who will be in the forefront of the expanded study of the seas. This training should go hand-in-hand with the conduct of research at universities and other oceanographic institutions.

Surveys of the ocean are of little value unless they can be done on a

world-wide basis. Oceanography thus becomes a natural area for extensive and friendly international cooperation. In fact, systematic surveys and research in all the oceans of the world represent tasks of such magnitude that international sharing of the work is a virtual necessity. In these endeavors, the United States can play a leading part if it now increases its deep-sea survey capability.

Expand Existing Agencies

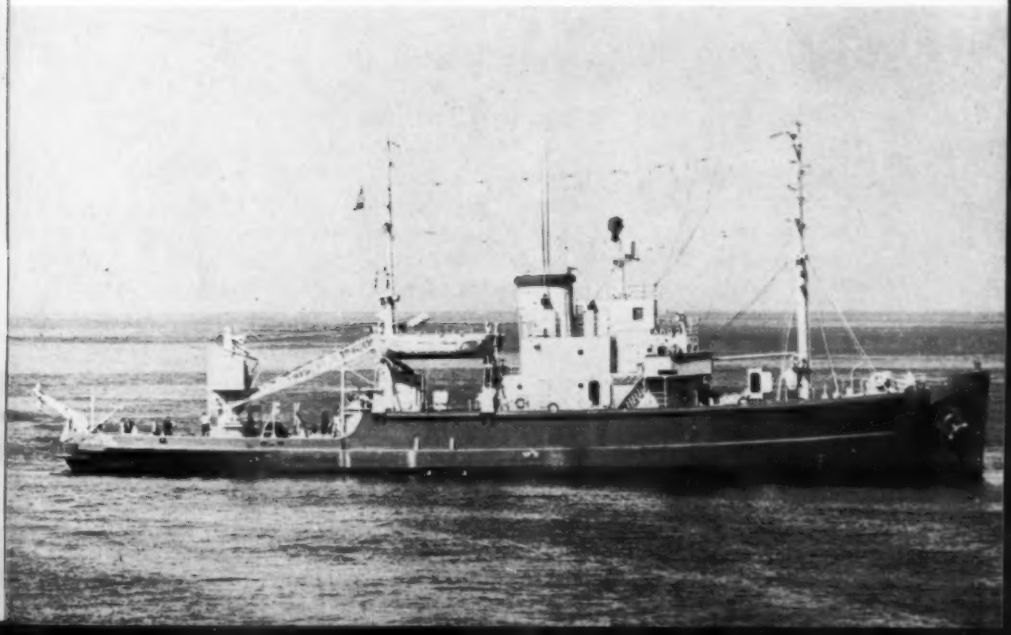
At present, the U. S. Coast Guard is limited in the extent of its scientific research work. The new program recommends the removal of restrictions on Coast Guard scientific work at sea. It would also provide for an extension of the operating season of the ships of the U. S. Coast and Geodetic Survey.

Altogether the President's proposals are most heartening to those of us who have long advocated "the extension of human knowledge by scientific study and exploration of the oceans in all their aspects, including the study of game fishes, food fishes, ocean currents, the geology, chemistry and physics of the sea and sea floor" (part of the preamble to the charter of the International Oceanographic Foundation).

Write Your Congressman

The proposals to the Congress represent a step forward in what must be a continuing effort to obtain and apply vital information about the sea, data that may ultimately determine

MORE AND LARGER RESEARCH vessels of *this type are urgently needed if the Free World is to keep pace with the Soviet Union's exploration of "inner space." This, the* R/V Argo, *was converted from a U. S. Navy salvage ship at a cost of $1,250,000 as a completely equipped floating oceanographic laboratory. Newer ships are being designed from the keel up for their scientific jobs. (University of Califorina, La Jolla)*



conditions of life, not only in the United States, but in the rest of the world as well.

Members of the Foundation, and others who realize the seriousness of the situation, would be well advised to see that this new oceanographic program is brought to the attenion of their Congressmen, urging them to approve adequate funds for the construction and operation of ship and shore facilities for research and survey, the development of new instruments for charting the seas and analyzing data, and particularly for training scientific manpower.

Meanwhile there should be no slackening in the part that individuals, corporations and foundations play in advancing the entire oceanographic program. Government aid is welcome, but in the free world it is the contributions of many that assure the ultimate success of any endeavor. Members of the Foundation can take pride that they were among the first to make known to the public oceanography's vital needs, and by their consistent efforts and support they have helped to bring them before the nation and the world. The Foundation and its publications will continue to advance the frontiers of the sea, and the furthering of research, scholarships, and exploration.

Members are urged to make such progress possible by taking the small effort to enlist new members, thus ever enlarging the circle of those whose interest and curiosity lie with the oceans and the spirit of discovery.

John F. Hennion

That oceanography has its perils was demonstrated in the tragic death of Dr. John F. Hennion aboard the research ship *Vema* in the Pacific off Chile, March 17, 1961. Dr. Hennion was killed when a depth charge he was preparing for an experiment exploded prematurely.

Dr. Maurice Ewing, director of the Lamont Geological Observatory, Columbia University, which operates the vessel, described the operation Dr. Hennion was carrying out as dangerous, but it had been done many times without incident. The usual practice is to slow the ship to about seven knots and drop half-pound charges of T.N.T. over the side at regular intervals. This creates an upsurge of sea bottom, samples of which are later collected and studied. At the same time sonic and other instruments record the effects of the explosion.

In paying tribute to Dr. Hennion, Dr. Ewing said that he was not only one of the world's few experts in marine seismic refraction and reflection investigations, but also "a superbly good man. I have never worked with a more skillful, more reliable or more conscientious scientist." Dr. Hennion is a co-author of five Lamont Geological Observatory Technical Reports and other scientific papers.

WHERE SEA MONSTERS ARE BORN. *In the forecastles of small sailing ships and in little inns like these in the port of Bristol, England, sailors in olden times would meet and swap stories of strange creatures they had seen (or thought they saw) on voyages to the far places of the earth. Tales handed from mouth to mouth eventually were transferred to print. Some of the monsters were purely imaginary, the result of trying to outdo a fellow narrator; others can be recognized as familiar sea creatures distorted to embellish a good story. (British Information Services)*

Sea Monsters in the Telling

By F. G. WALTON SMITH

FROM THE TIME he first encountered the sea, man has believed in sea monsters. These beliefs have survived remarkably well the passage of years, as tales handed down from mouth to mouth gradually became transferred to print and exposed to the attention of growing scientific knowledge and scepticism. Some of the monsters were purely imaginary, some related to strong underlying religious beliefs and symbols. Others, such as the giant sea serpent, may be based upon faulty observation and

CAN THIS BE A WHALE? *After passing through many narrators we have a sketch of a monster with large tubular structures, from which it squirts huge torrents of water. This "Physeter" or "Demon Whale" may have been a sperm whale, in spite of the fact that whales do NOT squirt water, but moist air, and have have no tubular breathing appendages. (From an early print)*

propagated by wishful thinking. But in the early literature there is also a queer group of monsters in which modern marine biologists are easily able to recognize existing, even well-known, sea creatures, grotesquely distorted by the inclination of early sailors to improve a good tale.

Early chroniclers of natural history were not too careful about their sources of information and were, in fact, rather apt to describe as first hand knowledge and even to provide detailed illustrations of sea monsters which were obviously based upon the overenthusiastic tales of fishermen and travellers. They also copied the works of earlier authors, often without giving due credit and in doing so incorporated further mistakes and exaggerations.

Barnacle Becomes Goose?

The history of the mermaid is a long one and deserves space to itself. It appears to be more than the result of deliberate exaggerations of actual observations. Instead there is evidence of a deep rooted instinct on the part of human beings to personify sea creatures (See "Science and the Mermaid," *Sea Frontiers,* Vol. 5, No. 2, p. 74). Equally involved is the strange case of the barnacle which grows into a goose (See "The Flying Barnacle," *Sea Frontiers,* Vol. 3, No. 3, p. 162). But there are many more cases of distorted biology among the ancient naturalists.

Olaus Magnus, writing in the middle of the sixteenth century, gives some fantastic descriptions of whales. Their square heads are provided with enormous sharp horns, like a fearsome spiked dog-collar. The eye is red and fiery and at night is visible at a distance to sailors at sea. No whale answers this description but the writer gives the show away when he says that they are reputed to be whales, off the coast of Norway. The name is correct, the description fanciful.

Elephant Tusked Whale

Another kind of whale is 200 cubits long and a deliberate destroyer of ships. The author and his successors who quoted him note that the whale has six foot long tusks and large tubular structures, from which it squirts huge torrents of water. No doubt he refers to the sperm whale, in spite of

the fact that whales do NOT squirt water, but warm moist air, and they have no tubular breathing appendages, and no elephant-like tusks.

Other curious whales in ancient literature are the spineless ones described by Herodotus as living in the River Dnieper — "fit for salting" — and the hairy ones, with faces resembling rather unpleasant human beings, described by Conrad Gesner, a professor in the University of Zurich in the first half of the sixteenth century. None of these, however, appear to reflect anything but a desire to outdo the older authors.

Eric Pontoppidan, Bishop of Bergen, writing in 1751 gave an account of the Giant Kraken which is unquestionably based upon the giant squid, of which a number of more or less complete specimens exist today at Marine Biological Stations or museums. ("Hunting Sea Monsters," *Sea Frontiers,* Vol. 5, No. 3, p. 134.) He quotes a fisherman who saw the kraken rising to the surface of the sea, so that some estimate could be made of its size. ". . . its back, or upper part, which seems to be in appearance about an English mile and a half in circumference, (some say more, but I chuse the least for certainty) . . ."

Squid Climbs Fence on Shore

Pliny, quoting Trebius Niger, describes a squid which was in the habit of leaving the sea to eat fish out of pickling barrels, even though it was obliged to climb a fence to do so. When caught, after a fierce fight, it was found to weigh 700 lbs. Even Pliny, who apparently accepted this tall tale, was easily outclassed by Pontoppidan's creature of 8,000 foot circumference.

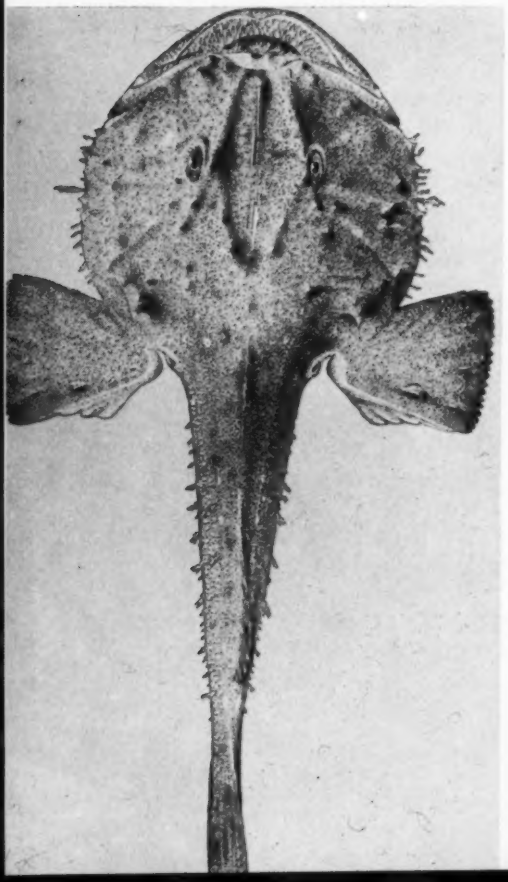
Olaus Magnus, who gives a detailed account of the kraken, or polypus, apparently illustrated it from his own description and became somewhat confused in doing so. His drawings

COMPLETE WITH SCALEY MITRE *comes the Bishopfish. This odd creature is based on the fancied resemblance of some fish to a bishop, but the illustration was obviously drawn solely from the name. Because Gesner records it from the coast of Poland, the original bishopfish may have been a sturgeon. (From an early print)*

show a giant lobster-like creature rather than a squid. The same pictures are faithfully reproduced by his contemporary, Professor Gesner, and by Aldrovandus, half a century later. The confusion seems to arise, once more, because these early naturalists based their illustrations and figures

THE MONKFISH IN ALL HIS IMAGINARY GLORY. *Gesner, an early chronicler of sea life, says the Monkfish or Sea Monk was caught off Norway, in a troubled sea, and he quotes Boeothius as describing a similar monster found in the Firth of Forth. (From an early print)*

IT IS A FAR CRY *from this ugly creature, the angler fish* (Lophius americanus), *and the gaudy monkfish of the Middle Ages. Yet scientists can see some resemblance, and certain authorities today list monkfish as an alternate name for this dweller of temperate waters along the Atlantic coast of North America.* (Fishes of North and Middle America)



upon a vague and fanciful tale, rather than first hand knowledge. At any rate, their description, which fits the squid in other respects, mentions toothed nippers, eight feet and also some small feet.

In further writing they even seem to suggest that because of having arms or tentacles in a radial arrangement, starfishes might grow up to be young kraken.

Professor Gesner fell into a similar trap in describing and picturing the monkfish and bishopfish. The names

were apparently based upon some fancied resemblance of existing fishes to a monk and a bishop. The illustrations obviously were drawn solely from the names. One may speculate as to the identity of the originals. Possibly the monkfish was an angler fish which goes by the same name today. The bishopfish, which Gesner records from the coast of Poland, may have been a sturgeon.

It is, of course, natural that fishes should be named after their resemblance to more familiar objects on land. Hence, the sea horse, the hogfish, the sea cow, and sea calf have been applied to creatures fairly common in the sea. The early naturalists, however, having only the name on which to go, were free to invent a description which fitted the name, rather than the original object.

Thus, our familiar sea horse is described by Olaus Magnus as having a horse's head, but feet and hooves like a cow and a forked tail. The same author also interprets the sea cow as a strong and angry monster, equally at home on land or sea, whereas the real Mediterranean sea cow or dugong is a rather shy and harmless creature, and, though ugly, is a probable contributor to the mermaid legend.

The sea calf, by which Olaus Magnus obviously means the seal, by virtue of its name entraps the author into describing a creature with a voice like a bull, and having four feet and no ears. The illustration also shows bovine horns. Incidentally, it has no ears because ". . . they would take

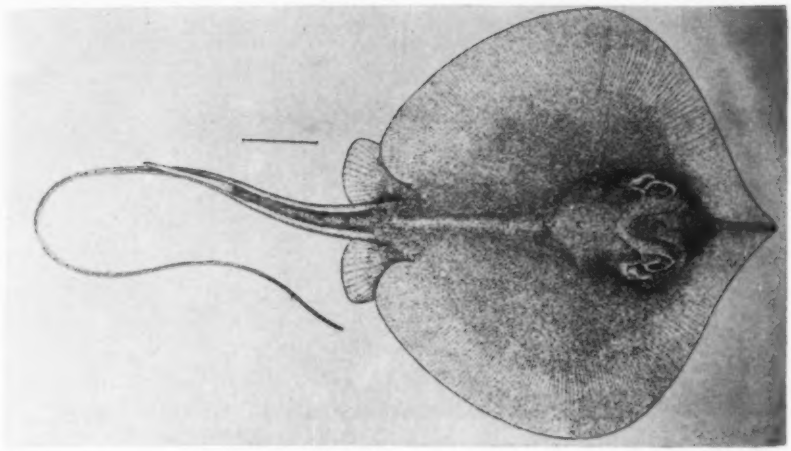
GALLOPING SEA HORSE. *Olaus Magnus described the sea horse of his day as having a horse's head, but feet and hooves like a cow, and a forked tail like a fish. Feeding on both the land and in the sea, Magnus adds, "he is seldom taken, although he grows to be as big as an Ox . . ." (From an early print)*

in much water, and hinder the swimming of it . . . The right fin if placed under one's head will promote sleep. The skin, made into a tent, is a sure protection from thunder and lightning!"

The Terrible Dogfish

Perhaps two of the best known fishes in the northern seas are the dogfish and the skate or ray. It is hard to recognize these by their early description, and the illustrations of Professor Gesner are grotesque cartoons. Olaus Magnus writes of the cruelty of the dogfish and kindness of the ray. ". . . There is a fish of the kind of Sea-Dogfish, called Boloma, in Italian, and in Norway, Haafisck, that will set upon a man swimming in the Salt-Waters, so greedily, in Troops, unawares, that he will sink a man to the bottome, not only by his biting, but also by his weight; and he will eat his more tender parts, as his nostrils, fingers, . . ." He goes on to say that the ray comes to the rescue. ". . . to revenge these injuries; which runs thorow the waters armed with her natural fins, and with

THIS IS WHAT THE ANCIENTS *did to the sting ray. Sea Dragon they called it, and Gesner here shows it as the most frightful-looking of oceanic monsters. Pliny writes of it: "The Sea Dragon again, if caught, and thrown on the sand, works out a hole for itself with its muzzle, and with the most wonderful celerity." (From an early print)*



HERE IS WHAT TODAY'S *sting ray looks like. Even in its natural form the Atlantic sting ray* (Dasyatis sabina) *is a rather fearsome looking creature as it glides along the water, flapping its outer membrane like a bat's wings and swishing its stinger-tipped tail.* (Fishes of North and Middle America)

some violence drives away these fish that set upon the drown'd man, and doth what he can to urge him to swim out."

Pliny mentions the sting ray, which is harmless enough if left alone. ". . . There is nothing more to be dreaded than the sting which protrudes from the tail of the Trygon, by our people known as the Pastinaca, a weapon five inches in length. Fixing this in the root of a tree, the fish is able to kill it; it can pierce armour, too, just as though with an arrow, and to the strength of iron it adds all the corrosive qualities of poison."

Thus, many of our recognizable sea creatures, harmless though we now know them, were at one time pictured and described as fierce, grotesque monsters of fantastic shape or colossal size, thanks to the imagination of travellers and the naive attitude of naturalists who felt no necessity to see the thing they described.

Biologists today are occasionally chided for neglecting nature for the laboratory and test tube, and thereby overlooking important observations on the living animal in its natural habitat.

Perhaps consolation may be obtained from the reflection that some of the early naturalists felt little need to see the animal at all.

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Operation Drum Drop

By HARRIS B. STEWART, JR.
U. S. Coast and Geodetic Survey
AND ARNOLD B. JOSEPH
U. S. Atomic Energy Commission

PROBABLY THE HOTTEST oceanographic topic today is the question of the sea disposal of radioactive waste. At one end of the argument are those who say that the ocean is, in fact, a big hole in the earth, a good place to dump things we don't want around. At the opposite extreme are those who say that no wastes whatsoever, and especially radioactive wastes, should enter the ocean. A practical and safe solution to the problem lies somewhere between these two extremes, but where, how close to which end?

Big Research Program

This question cannot be answered for all kinds of radioactive waste and all marine locations without going to sea and getting basic information. Realizing this, the Atomic Energy Commission for several years has been supporting oceanographic research at numerous institutions, research pointed directly at such questions as: What marine organisms concentrate what elements and why? How effective are sediments as a sponge for soaking up radioactive material? What mechanisms in the ocean lead to the dilution and mixing of contaminants? How great are the effects of diffusion and water currents in disposal?

Several years ago the Coast and Geodetic Survey was asked by the Atomic Energy Commission to obtain bottom sediment samples in an area where low-level material had been dumped at sea. Since then the two agencies have continued their cooperation. The Atomic Energy Commission needs the oceanographic knowledge, and the Coast and Geodetic Survey has the ships and the men to collect the required data at sea.

What Happens to Dropped Drums?

As part of the program, the Coast and Geodetic Survey in June, 1959, undertook a two-part study off the New England coast for the Atomic Energy Commission. One phase consisted of detailed studies of the marine environment in an area east of Boston, where old ammunition, chemical wastes and some packaged low-level radioactive wastes had been

FOR TAKING A BIG GULP *of deep water. This sixty-litre bottom water sampler was borrowed from Woods Hole Oceanographic Institution. It contains a sliding chamber, which is released by a large "messenger," and seats firmly on the bottom plate to trap water inside at the time of tripping. It can obtain samples at any depth desired. (U. S. Coast and Geodetic Survey)*

STANDING BY FOR A DRUM DROP. *Scuba divers from the Coast and Geodetic Survey and the Fish and Wildlife Service are ready to descend 100 feet to take underwater motion pictures of the descent and landing of the steel drum here being readied for dropping. Instead of radioactive materials, the drums used in the test were loaded with ordinary broken glassware, rags, etc., plus a brilliant yellow-green dye, which dissolves rapidly on contact with water. A leaky or broken drum would thus become apparent, and the need for stronger containers would thus be obvious. (U. S. Coast and Geodetic Survey)*

dumped. The other phase was a study of what happens to the packaged drums when they hit the ocean bottom. It was this part of the survey that gave the operation its name — Operation Drum Drop.

Operation Drum Drop was carried out from the U.S.C.&G.S. Ship *Gilbert*, a 78-foot survey vessel normally used for coastal charting purposes. She had just completed some studies for the U.S. Army Corps of Engineers and would spend two weeks on this Operation for A.E.C. before starting the scheduled season of charting the waters around Martha's Vineyard and Nantucket.

The ship's staff welcomed aboard the two skindiving C.&G.S. oceanographers and a man from the A.E.C. who had met the team at Woods Hole, and over steaming mugs of

coffee they discussed last minute details of the operations which had been planned well in advance.

Yard Workmen Scared

At the nearby buoy yard of the U.S. Coast Guard, fourteen heavy 55-gallon oil drums had arrived some days before. They had come from the Brookhaven National Laboratory and from the Atomic Power Division of Westinghouse Electric. Although the bill of lading specifically stated that they contained no radioactive material, the mere mention of the word "radioactive," plus the ominous appearance of the drums, caused them to be avoided by those working in the buoy yard—an example of the psychologic or public relations problems involved in this business.

But for one detail, these drums were identical to those used for the disposal of low-level radioactive wastes at sea. They contained broken glassware, rags, and other research

OVER SHE GOES! *A steel drum used in the tests, containing no radioactive materials but similar to drums which do, is pushed overboard from the USC&GS Ship* Gilbert. *The drop site is located by horizontal sextant angles, being taken left. The descent and the bottom impact of this and other drums of simulated low-level radioactive waste were photographed by other Coast Survey oecanographers, who were waiting on the bottom 100 feet below. (U. S. Coast and Geodetic Survey)*

INSPECTION PARTY AWAY! *Scuba divers hit the water from the USC&GS Ship* Gilbert *to descend to the sea bottom. There they will examine the drums dropped the day before, to determine if any are broken or leaking. Left to right, Mr. G. G. Salsman, C&GS; Dr. H. B. Stewart, Jr., C&GS; and Dr. John Wise, Fish and Wildlife Service. (U. S. Coast and Geodetic Survey)*

refuse. The wastes were enveloped in and weighted with concrete within the steel drums.

Active Disposal Site

Perhaps even more important than the drum tests were the detailed studies of the site actually used for sea disposal of radioactive wastes for a number of years. For these would actually measure the contamination, and also indicate the natural forces which determine dispersion, uptake and reconcentration of radioactivity escaping the containers.

Like a doctor giving a physical examination to a patient, the U.S.C. &G.S. Ship *Hydrographer,* operating out of Boston, examined the site in minute detail. Just as at Brown's Ledge, surface and subsurface currents were measured. However, now these would indicate the rate and extent of mixing in case the waste containers did not fare as well as in the Brown's Ledge tests.

Other measurements were made

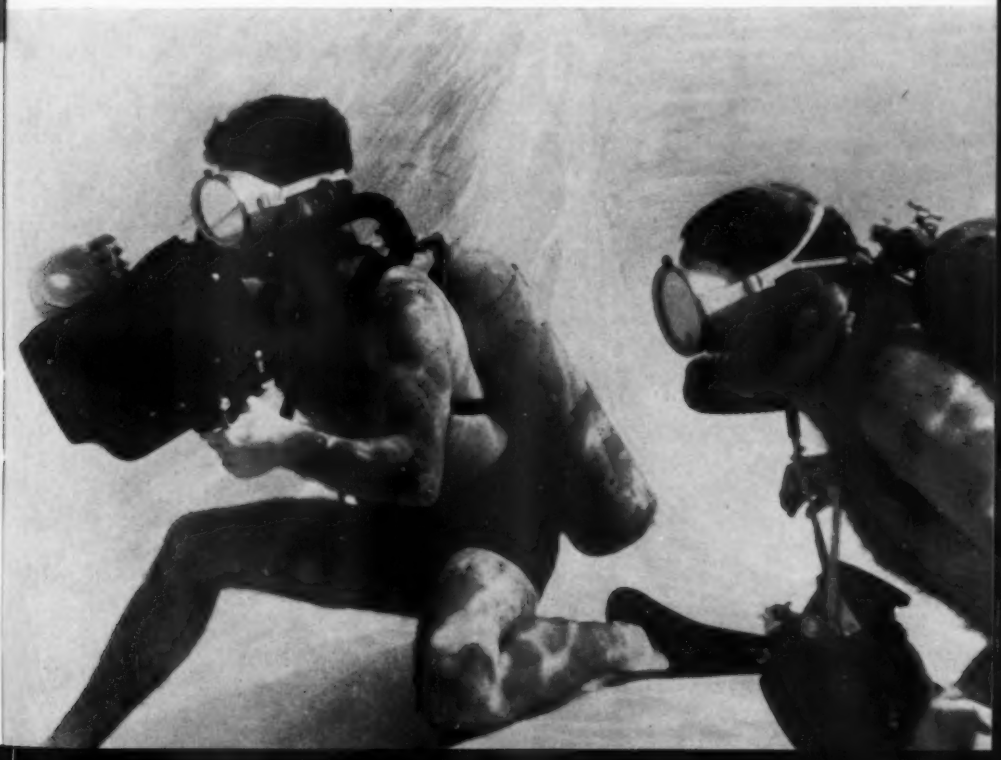
and samples collected as follows: Using precise electronic positioning equipment, nineteen core samples of the bottom, evenly spaced in an area two miles in diameter, were collected. Large-volume samples of the sediment were obtained and screened for the small organisms that live in the bottom muds. Large volume water samples were also collected, and these together with the sediment samples and screened bottom organisms were turned over to the Robert A. Taft Sanitary Engineering Center of the U.S. Public Health Service for radiochemical analyses.

"Hottest Thing Aboard"

As each sample was brought to the surface, it was carefully checked with a Geiger counter just to be sure. As one of the oceanographers aboard later reported, "The hottest thing aboard was my watch dial." The needle on the counter never got off the peg.

All of the samples—of the water, bottom sediments and bottom organisms — were analyzed as carefully as possible for any increased amount of radioactivity attributable to the waste disposal operations. To be sure, radioactivity was detected by the sensitive Taft laboratory instruments, but it was the same range as the sum

TANK TESTS OF EQUIPMENT. *Before using underwater cameras at sea, photographers assigned to Operation Drum Drop tried out their film and lenses under laboratory conditions. At sea visibility was often reduced to 20 to 30 feet, but good photographic results were obtained. (U. S. Coast and Geodetic Survey)*



HOW FAST IS THE CURRENT FLOWING? *A scuba diver makes an underwater check of a current meter off Georges Bank. This is similar to the equipment used on Brown's Ledge, during "Operation Drum Drop," in June 1959. It was important to know the flow or speed of underwater currents in the area before attempting to photograph the descent and landing impact of the test drums. (U. S. Coast and Geodetic Survey)*

of fallout activity and natural background activity found at other ocean sites where no wastes were disposed. There was no indication that sea disposal in this two-mile area had changed the level of activity at all.

These results are not too surprising if you consider the amount of water and large magnitude dispersing forces that are present in the ocean. If there were no restriction limiting the amounts of radioactivity disposed at sea—if the sea was used for disposal of high activity liquid fission product wastes—it would be much easier to find the disposed wastes.

However, the important fact is that indiscriminate dumping does not and is not going to take place. Studies such as Operation Drum Drop, the surveillance of the disposal site and other studies at sea, plus numerous laboratory studies being sponsored by the A.E.C., are all pointed toward acquiring the knowledge necessary to be sure that any disposal of radioactive material at sea will not be injurious to man.

A. R. Luedecke, General Manager of the U.S. Atomic Energy Commission, summed up the A.E.C.'s position in his Congressional testimony last July, "At the offset, it should be emphasized that the primary objective of the Commission with respect to sea-disposal operations is to assure the protection of man and his natural resources." And the Congressional Joint Committee on Atomic Energy, at the conclusion of the most extended hearings on waste disposal ever held, announced: "According to the best judgment of the scientific experts who testified during the hearings, radioactive waste management and disposal practices have not resulted in any harmful effect on the public, its environment or its resources."

Replaces Radioactive Waste

Instead of radioactive material, the laboratories had substituted fluorescein dye, a brilliant yellow-green powder which dissolves and spreads rapidly on contact with water and which can be detected in very small concentrations.

The plan was to load these drums aboard the *Gilbert* four or five at a time and proceed to a chosen area,

where both sandy and rocky bottoms were available. Skin divers with a motion picture camera would be at the bottom to photograph the descent and bottom-impact of these drums as they were dropped from the ship. Enough fluorescein dye was placed in each package so that if it did break open, the escaping dye would be noticeable.

Beating the Drums

Before the drums were dropped, however, the *Gilbert* surveyed the area where they would lie. We wanted to be sure that we had a rocky bottom for some of them to land on, for those drums were to get as tough a test as we could give them. We also wanted a sandy bottom nearby so that we could watch what happened when the drums landed on the softer material.

It was also very desirable to know what currents would be acting on the drums as they lay on the bottom. As a current flows past an object on the sea floor, it creates a turbulence that increases the ability of the current to pick up sediment. Would the currents be strong enough to scour around the drums on the sandy bottom, perhaps to the extent that they would become completely buried?

Survey of Bottom

The test area lay at the mouth of Buzzards Bay, some twenty-three nautical miles from Woods Hole. The chart shows a rocky shoal called Brown's Ledge rising to within 48 feet of the surface. On an inspection dive, the divers found the ledge to be a great pile of rounded glacial boulders. Some 1000 yards to the north, we found an area of sand in 100 feet of water.

The site was just what we had hoped for. Using horizontal sextant angles, we pinpointed the site on the chart and put a marker buoy over. Then a yellow boat-like buoy with a tall radio antenna was anchored on the crest of the ledge. This supported three current meters, one at the surface, one at mid-depth, and one near the bottom. Observations on the speed and direction of the current at each depth were transmitted to the ship every half hour for four days.

Rotary Tidal Currents

From this information, it was learned that the currents at each depth were primarily rotary tidal currents with a small nontidal current flowing southwest out of the bay. Current drift bottles, supplied by the Woods Hole Oceanographic Institution, were released every hour during the current measurements. Those returned provided us with a picture of the general surface current pattern of the area. Hourly measurements of the temperature-depth profile gave information on the water regime over the ledge, and a bottom-mounted temperature recorder provided a continuous trace of the water temperature right at the bottom.

The first load of drums was put aboard the *Gilbert* early on the morning of June 24th. As the ship ploughed along past the Elizabeth Islands, the sky was overcast with occasional light rain. The Coast

Guard had marked the Brown's Ledge site with a large buoy the day before, so we were able to find the spot readily and to anchor on station, even though rain had by then blotted out all sight of land.

Bombarded with Drums

We had hoped that as the skin divers swam near the bottom at 48 feet they would be able to see the outline of the ship's hull above, but this was not to be. The combination of overcast sky and a fairly heavy concentration of suspended organic material in the water reduced the underwater visibility, so that looking upward they could see only for about 20 feet into the dull yellow murk.

Back aboard the *Gilbert,* the divers conferred with the A.E.C. man and Captain Keith. It might be days before the underwater visibility improved; but if men on the bottom were to be bombarded with 1200-pound drums of concrete, it was very desirable to know where they were coming from.

Ship Outlined by Lead Lines

We decided to try to outline the ship and the drop zone on the bottom by suspending a set of lead lines from various points about the ship. Thus, the men on the bottom were able to orient themselves by means of the lines that disappeared into the murk above. Conditions were marginal but it was worth a try. The divers checked each other. Both were ready and the movie camera was pointed upward along the line that led to the spot where the first drum would hit the water. Two tugs on the signal line meant we were ready for the first one and the answering two tugs meant that it was on its way.

One of the divers (co-author Stewart) reported: "Our exhaled bubbles were noisy, so we held our breath, hoping to hear the drum hit the water above us. The sound was quite distinct and we knew it was coming. It seemed a long time that we stared into the yellow murk at the spot where the line disappeared above us.

"Then it came, a darker shadow at first just to the left of the line. It was turning slowly and seemed to be angling off to the left. It hit with a loud report about five feet from Garry Salsman who had the camera, bounced slightly, and settled on its side as a cloud of 'dust' started to rise and drift off down-current. We looked at each other and nodded; we were both relieved to know that the operation could go on as planned. Swimming over for a close inspection, we found the drum apparently undamaged. There was a dent where it had hit a large boulder, but it appeared tight and no dye was coming from it."

One Springs Its Lid

During that day and the two following days, six more drums were dropped on the rock pile, Brown's Ledge and a similar set of seven was dropped in 100 feet on the sandy bottom. Even though the drums hit at an estimated speed of twelve to fifteen miles an hour, not one of them split open to spew its contents about the ocean bottom. One drum

that seemed to hit especially hard on the rocks did spring the metal lid. Air bubbles poured out around the rim and then dye was seen escaping around the edges.

Two drums filled with heavy broken glass, and with concrete at the bottom, landed upright and were partially crushed by the pressure (about forty-four pounds per square inch at a hundred feet), but otherwise remained intact.

Rigorous Impact Test

Any packaged low-level waste disposed of at sea will be dropped in water considerably deeper than the Brown's Ledge area, and the bottom material at such places is generally softer than these sand and rocky bottoms. It is most unlikely that any actual drop will ever be on a bottom as hard as that on which these dummy drums were dropped. Operation Drum Drop was a rigorous impact test and the containers stood up well.

During the summer of 1960 the Coast Survey divers returned to the drop site on Brown's Ledge to see how the drums had fared in their year on the bottom. The visibility was poor—six to eight feet horizontally—and the water temperature was in the low fifties. Carrying a taut line between them, the divers swam just above the bottom, in a sort of underwater minesweeping operation, until the drums were located.

Drums Survive Tests

There had been some slight scour around the drums, and one that had landed upright had become tipped, but other than that they were in the same positions as when they had been dropped the year before. However, the exposed portions of the drums had been completely covered with growing organisms which obliterated the identifying marks and made the drums almost indistinguishable from the many drum-sized boulders in the area. The organisms appeared to be filamentous algae, hydroids, and bryozoans. The important thing was that the drums had not opened nor had they moved appreciably.

FROM THE COLD DEPTHS—*Is it "hot"? Coast and Geodetic Survey oceanographers test a sediment sampler with a geiger counter, before bringing it aboard the USC&GS ship* Hydrographer. *It contains a load of bottom sediment from 102 fathoms (612 feet) off the New England coast. There was no measurable atomic activity in the sample. (U. S. Coast and Geodetic Survey)*

What-Was-It?

A VERY BRIEF ARTICLE, with an accompanying photograph, about a mysterious framework washed up by the sea at Palm Beach, Florida ("Bamboo What Is It?" *Sea Frontiers,* November, 1960), has intrigued quite a number of readers, some of them sufficiently to write to the editors, giving their theories and comments, as well as reporting additional finds.

First of all, the editors must confess, not being experts in the monocotyledons (corn, grasses, palms, bamboos, etc), they mistook the structural material for bamboo. At least one member of the staff, however, thought it might possibly be rattan.

Expert Botanical Opinion

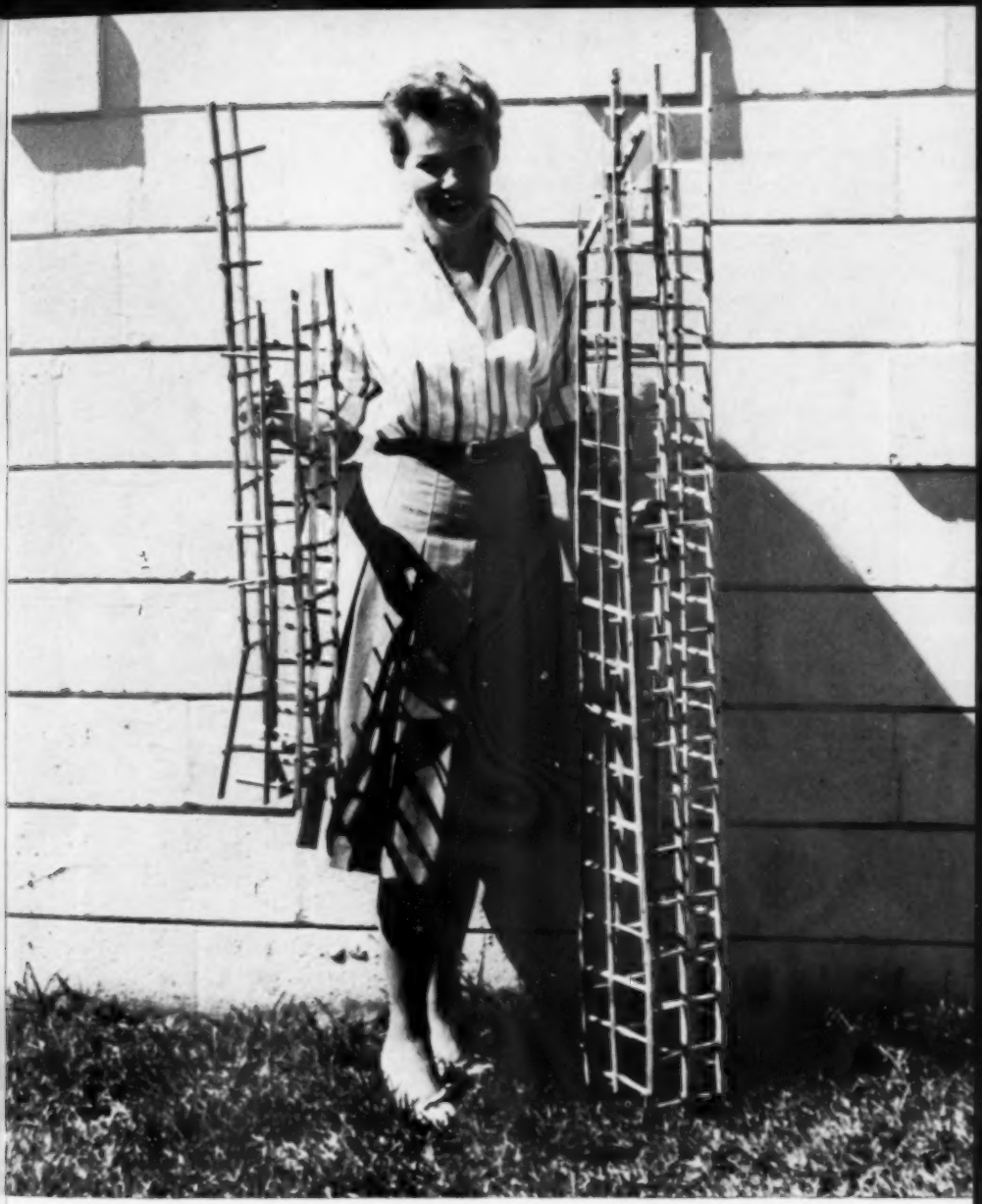
To settle the matter, a small portion of the object was sent to a botanical expert at the Fairchild Tropical Gardens, Coral Gables, Florida. After careful examination he wrote: "It is definitely not bamboo, but a mid rib of a palm leaf. The palm leaf used was of the feather or pinnate type leaf, as opposed to the fan leaf type plant. As we do not know the particular species of palm it came from, it is hard to say what its country of origin was, but I would hazard a guess that it is from the Caribbean or northern South America. There are two main types of plant groups, one of which is the monocots and the other is the dicots. The palms are, of course, in the same group as the bamboo, the monocotyledonous, as are corn, grasses, etc."

Meanwhile, several additional finds of similar frameworks have been reported along the east coast of Florida from Fort Lauderdale to Palm Beach, and letters from members mention the use of such devices in such faraway places as Alexandria, Egypt, and the Philippines (see excerpts from this correspondence at the end of this article).

Found in Florida Bay

Just as we go to press, a student at South Dade High School, Homestead, Florida, has sent in what is apparently a full-size framework, 42 inches long, but with other dimensions matching those of previous finds. He had read the original article in *Sea Frontiers* and recognized the similar framework, although it was half buried in mud and marl.

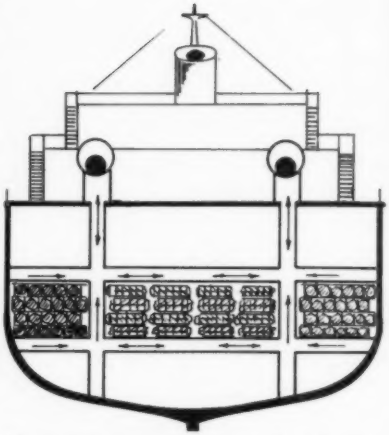
The odd aspect of the student's discovery is that the frame was found on Shell Key, off Islamorada, upper Florida keys, *on the Florida Bay side.* Could it, like the other objects found along the Florida coast, have drifted with the currents of the Caribbean and the Gulf of Mexico, and then have been diverted by high northeast winds, near Key West, and pushed into Florida Bay? This seems to be the most logical explanation as to how it reached the area where it was found.



SINCE THE DISCOVERY *of the framework originally described (left) several additional finds have come in. The one being held at the right by Audra Barker, Editorial Assistant, was discovered by a high school student in Florida Bay, north of the Florida Keys. It is apparently full size, 42 inches long. Its other dimensions, and the material used in construction, match those of previous examples. (E. John Long)*

Following are excerpts from some of the letters received by the Foundation since publication of the original article in November, 1960:

Dr. W.E.B.H., of Chambersburg, Pa., expresses this opinion: "I am a Director of a Hospital Laboratory, and happened to show the illustration to a young medical technician trainee from the island of Cebu, the Philippines. She said she was quite familiar with the object—that fishermen made these of split bamboo as corner anchors, their bases buried in shallow water, anchoring small fishnets arranged in rectangles. If that be true, what a wondrous tale of travel that frame could tell of its journey to our *Atlantic* shores!"



USED FOR VENTILATION *on board cargo ships? A letter from a Canadian correspondent reports that similar frameworks are used for air passages needed in shipping bagged onions or rice over great distances. The drawing is based on details supplied in his letter and shows how the frames, marked with arrows, separate the bags. (Drawing by Richard Marra)*

Rifle Cases?

Member J.R.W., of Delray Beach, Florida, reports: "We found identical sections of these things washed up on the beach all the way from Palm Beach to Boca Raton. There were dozens of them. I have one at home about four feet long. Pizio's Restaurant in Delray has one hanging up which carries a sign: 'What Is It?' No one in this area has come up with an explanation as yet, but one romanticist said they were cases for rifles being smuggled to Cuba, and that they were dumped overboard when capture appeared certain."

Miss M.K., of Richmond, California, declares: "On my first glance at your bamboo puzzle I guessed it was a bridge built to withstand the stress and strain of wind and waves by some ingenious person, and fortunately found by your researchers in Florida."

Mock-Up of River Kwai Bridge?

Mr. E. S. W., of Boston, Mass., adds a facetious note: "Seems clear enough to me: it's a bamboo mock-up of the Bridge over the River Kwai. The Director was so disgusted with it that he flung it into the Pacific off Malibu one night and it made its way to Palm Beach by traditional currents."

From Ottawa, Canada, Mr. D.J.C. writes: "I have seen this type of object used for air passages needed in the shipping of bagged onions or rice over great distances. They need ven-

tilation continuously during passage, and this is attained by a complicated system of air ducts placed end to end between every fourth bag longitudinally and traversely in horizontal lines, and also between fourth bags in vertical lines.

Used as Plant Trellis

"They are made in the Middle East and have been used to my knowledge when loading onions in Alexandria, Egypt. The absence of nails is due to sweating of metal in wide temperature ranges. There may have been many sighs of relief from ship's captains and importers when a cargo of onions is discharged fit for market, but just as many shippers, I suspect, have gone bankrupt before the use of these air ducts."

Mr. A.J., of Fort Lauderdale, Florida, reports: "In August, 1960, we picked up a similar piece on the Fort Lauderdale beach — approximately four feet long and in better condition than the one in your photograph. We have been using it as a trellis for a climbing plant, and would certainly be interested in knowing its origin and purpose."

A postal card from Lake Patzcuaro, Mexico, is submitted by R.H.G. of Miami, who adds: "I think your 'What Is It?' is shown in this old postal—a fish trap."

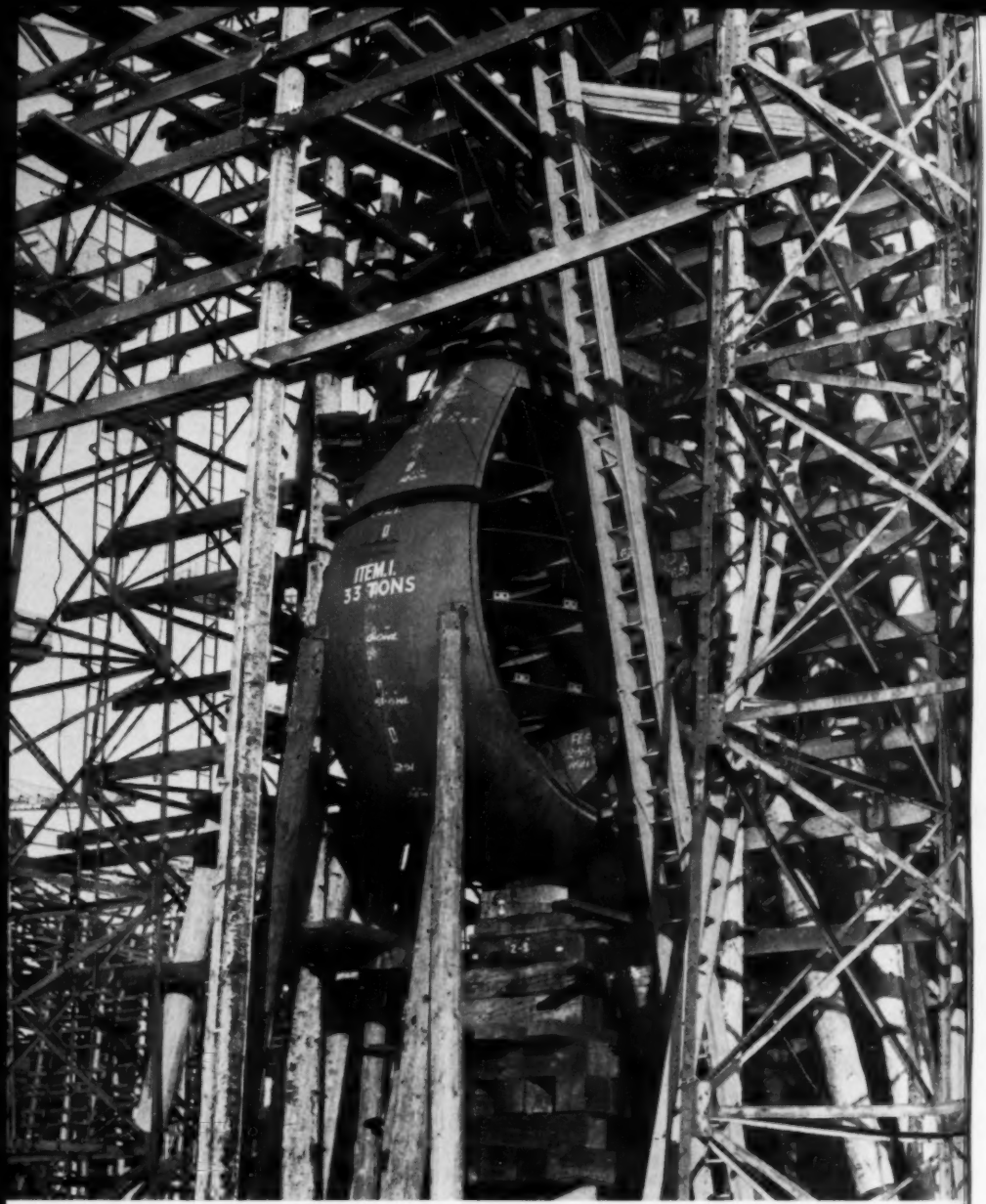
With returns still coming in from members, the editors have decided, perhaps rather supinely, not to take sides. But they will continue to print excerpts from letters or other comments from readers. Particularly desired is the address of any company or individual manufacturing these frameworks. Also, just what are they called?

Underwater Orchestra

Have you ever heard a fish whistling? Professor James M. Moulton of Bowdoin College has! In fact, equipped with fishing line, assorted bait, and a microphone, he has been tracking some of the strangest underwater music ever heard off Australia's Barrier Reef.

Two sounds prevail — the first, a weird whistle that sometimes climbs three notes of the scale, and the second, a drumming noise that immediately scatters all other fishes in the area. According to Dr. Moulton, no porpoises were in sight to account for the whistling, and the soldier fish (common on the Great Bahamas Bank), which might explain the drum beats, makes a noise that is always ignored by other fishes.

While the mysterious "music" remains unexplained, Professor Moulton hopes to discover its source, for he believes that fishermen may some day use sounds which alarm fish sufficiently to drive them into nets.



CLOSE-UP OF BULBOUS BOW, *which gives the* Canberra *a bit of buoyancy. The conventional long and narrow bow pitches and crashes through heavy seas. The bulbous bow is a testing-basin development, and was used on late model battleships and carriers during World War II. (Harland & Wolff, Ltd.)*

The Anti-Seasick Ship

By GARDNER SOULE

EDITOR'S NOTE: The main thing science knows about seasickness is that it is still somewhat of a mystery. For example: Nobody knows what causes it—except motion. Although some recent drugs help (see your physician), the only infallible cure is to get off the ship. Are any people completely immune? Best evidence suggests that none—not even experienced sailors—escape altogether. But experience in sea travel does help. Fewer passengers become sick on their second voyage than on their first. Babies and old persons rarely get seasick. Men are less likely to be affected than women. The obese are possibly slightly more likely to become victims than the slim. Certain things may cause or aggravate motion sickness: noises, smells, tastes, vibrations. *Spectrum* (a medical magazine) reports that seasickness may have serious results to pregnant women, heart and TB patients, and those with hernias, epilepsy, or under emotional stress. Otherwise healthy people usually recover rapidly, with no complications whatever.

JOHN WEST, thirty-three, has just finished spending $45 million to keep you—and, he hopes, thousands of others—from becoming seasick.

West designed the 45,000-ton, 820-foot-long *Canberra,* a British superliner for Pacific Ocean service out of Britain to the South Seas, the Orient, and California and Canada. Now in the final stages of completion, she will make her maiden voyage in July.

Biggest Since Queen Elizabeth

The *Canberra* is the biggest ship built in the United Kingdom since the *Queen Elizabeth* in 1938. She will carry 2,335 passengers, a few more than the Elizabeth's 2,314, and more than any other ship in the world.

The *Canberra,* at $1,000 a ton, is also by far the most expensive passenger vessel Britain ever has built. As the money rolled out, West worried a lot about getting it back. "It might be put this way," he told the writer. "I always tried to place myself in the passenger's position. I've asked what I'd like the money spent for."

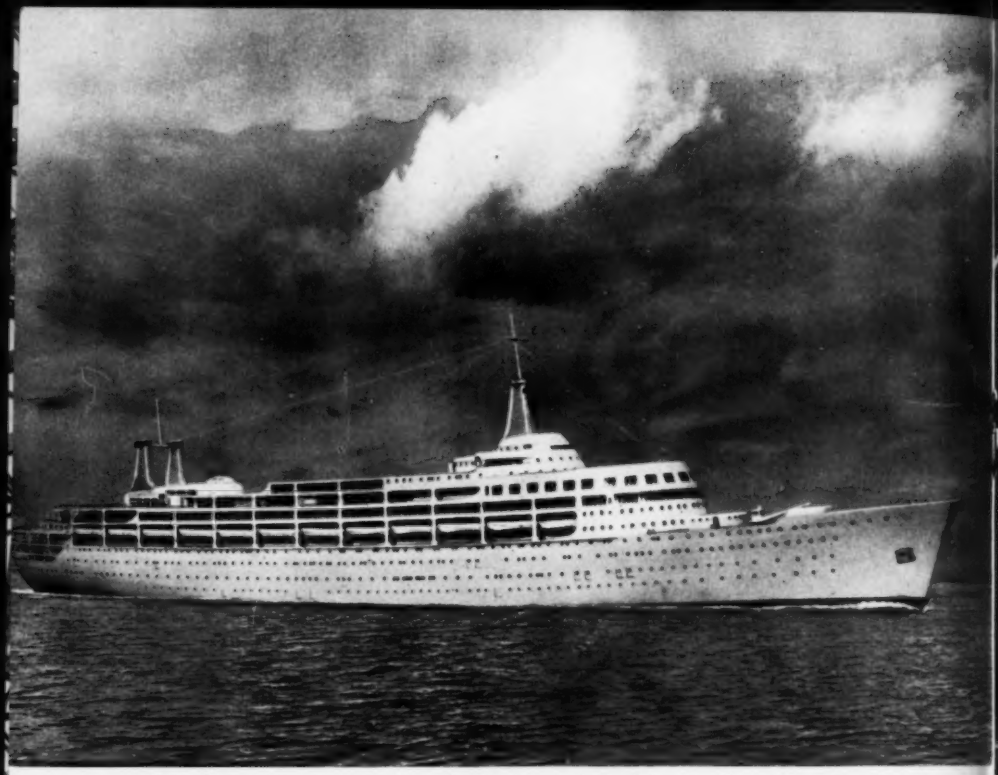
Sea-Kindliness

He has a word for what he thinks most ocean voyagers want most: "Sea-kindliness, or a minimum of pitching and rolling. We've put into the *Canberra* all the engineering things we can think of to guarantee the sea-kindliest action."

One feature is a bulbous bow. Pitching is what a ship does when she buries her bow deep into a wave, then lifts it high out of the water. It is caused partly by the reduced buoyancy of the knife-edge, necessary for the bow to cut rapidly through a normal sea.

Developed in Testing Basins

The bulbous bow is not entirely an innovation. It was used on late model battleships and carriers during



WORLD'S NEWEST SUPERLINER, *the* Canberra, *looks like no other ship. Funnels are far aft, lifeboats hang on a much lower deck than usual. This is an architect's drawing of the vessel which will go into service this summer. (Harland & Wolff, Ltd.)*

World War II, after being developed in model testing basins. Similar bows will be used also on other luxury liners, soon to appear, including the *France*.

Rolling, the side to side motion of a ship, will be checked on the *Canberra* by not one but two sets of stabilizers. The P. & O.-Orient Lines, owners of the *Canberra,* several years ago was the first shipping company to install single pairs of stabilizers on some of its smaller vessels. The company has been watching the food consumption and the general satisfaction of its passengers climb ever since.

The *Canberra's* two sets of stabilizers can be projected out beneath the waterline, like short, stubby airplane wings. Either set can be worked separately, or they can be worked together. "If she's not rolling much, we'll need only one set," says West. Two sets can bring the *Canberra's* roll down, he hopes, to a mere one or 1½ degrees, which is scarcely noticeable.

Reduces Corkscrew Motion

Captain Wild of the *Arcadia,* another ship of the P.&O.-Orient Lines, calls stabilizers the greatest advance

THIS 14-FOOT FIN *will exert 6,000 foot-tons of "lift" to smooth ocean roll. A Sperry Gyrofin stablizer, on the American atomic freighter* Savannah, *is similar to those on the new super-liner* Canberra. *In addition to providing more comfort for passengers, stabilizers reduce breakage of cargo and equipment. (Sperry Gyroscope Co.)*

ENORMOUS PLAY-DECK AREAS *are revealed in this photograph of a model of the* Canberra; *also wells or courts for inside-room light and air. Swimming pools (top deck and stern) are partly sheltered from the wind. (British Information Services)*

in ship travel in recent years. He explains that stabilizers reduce the roll on a ship, which, in turn, reduces the corkscrew motion (a combination of rolling and pitching), which is the nemesis of so many passengers.

Contributors to that Queasy Feeling

Noise, heat and vibration are regarded by thousands of sea passengers also as contributors to that queasy feeling. The luckless traveler whose economy-rate cabin is at the stern, hung over the grinding propellers, is particularly vulnerable. West's entire basic design calls for new arrangements. Where most vessels have their engines amidship, he places them nearer the stern, as on a tanker. Passengers ride in the center, traditionally the least rocky section of the ship, and far away from the engine room.

In addition, the 85,000 horsepower turbo-electric machinery runs so silently that the *Canberra* has already been nicknamed the "whispering giant" by testing engineers. Her two 30-ton propellers, 20 feet 6 inches in diameter, for the first time in any liner can be run "in broken step"—as an army crosses a bridge out of step — to eliminate vibration. Soundproofing includes insulated

bulkheads throughout to cut down noises of conversation, fans, elevators, footsteps, dance bands, and alas, also the swishing of the sea!

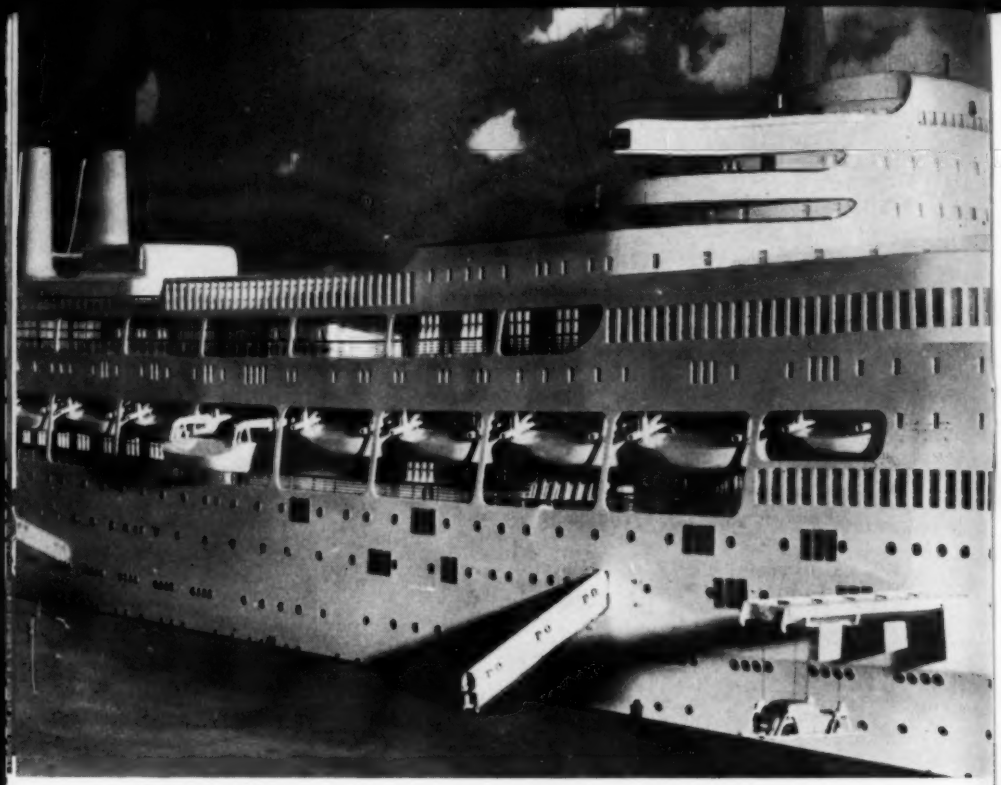
Air and light are believed by many travelers to prevent seasickness or, at the worst, to help cure it. West has designed many of his inside cabins on what he calls the air-light principle. Many cabins are grouped around courts that open onto the sea, so that even those located toward the middle of the ship get ample light and fresh air.

Many Climates Made Into One

The *Canberra* will sail through climates of all kinds, hot and cold, dry and humid, in its voyages from Britain through the Suez Canal to Australia, the Fijis, Hawaii, California, Vancouver, and, via Ceylon, home to Britain again. So air-conditioning will be used throughout the ship to resolve many climates into one. Passengers who crave only natural fresh air can get it on the top, or games, deck. So carefully is it screened that even when the ship is steaming at her regular 27½ knots (fastest for any Pacific passenger liner) into a 30-knot wind, they will not be blown away.

Not all the new engineering features about the *Canberra* are anti-

GIANT ANCHOR DWARFS *workmen in a Belfast yard as they join it to the anchor chain. While ship equipment has advanced greatly in recent years, no substitute has yet been found for the fluke-type anchor, although it has many variations. (Harland & Wolff, Ltd.)*



CLOSEUP OF MODEL *shows Carron cargo transporter (lower right), a new way to get automobiles on and off rapidly. One of the lifeboats is swung out (mid left) preparatory to lowering. (Harland & Wolff, Ltd.)*

seasick measures. The long-neglected sea voyageur will be happy to know that his comfort and convenience are being anticipated with a host of gadgets, gimmicks and devices, as well as careful planning. On most ships, baggage handling is a mad scramble, both on embarking and disembarking. More than 2,000 passengers, plus long trips, mean eight or nine thousand trunks and suitcases to get on and off.

On the *Canberra* baggage will be speeded aboard by conveyor belts, through the sides of the ship. Automatic elevators will unload them at any pre-selected deck. Automobiles of passengers will be quickly hoisted on or off by a side-loading device that raises the cars on a pallet, carries them over hold or deck, and lowers them into place.

Closed-Circuit TV

Much use will be made of closed-circuit TV. Movies will be telecast in staterooms, and, when necessary, announcements from the bridge at sea. The ship will also pick up and transmit to passengers any telecasts from local stations while in harbor. In the engine room, it will mean that the

chief engineer, at one central location, can read a battery of gauges and instruments operating in four machinery compartments. This will be an invaluable aid in rough or foggy weather when watertight doors are closed.

Glass-fibre lifeboats, which won't crack, chip, rot or rust, will be ready for any emergency, under any conditions. Instead of being located in the usual position aboard ship, the high boat deck, they will be nested three decks lower where passengers can climb in more easily. The boats will also need to be lowered a shorter distance.

Funnels, masts, and the entire superstructure are of aluminum—1,100 tons of it — the largest aluminum superstructure on any ship. The light weight makes possible an entire extra deck, adding to the passenger accommodations that give the *Canberra* the most of any ship. It also reduces top-heaviness, "the naval architect's nightmare."

Under the bow is a tunnel containing a propeller! This hole running athwartships is screened, to keep logs

AT THE EDGE OF THE "BAMBOO CURTAIN" *is Hong Kong, one of the glamorous ports visited on many around-the-world cruises. In the foreground is Victoria, on the opposite side of the harbor is Kowloon, both parts of the British Colony. (British Information Services)*

and debris out, but is never closed. The two-bladed propeller, 6 feet 6 inches in diameter, turns in either direction, moving the ship crabwise.

Its purpose is for docking, and it provides a 10-ton thrust in either direction. As this thrust comes right at the forward end of the ship, it not only assists in turning the ship, but it also helps to steer it into narrow dock entrances. With it, too, the ship can push off from the wharf with much less maneuvering, especially when a heavy tide is running. The Captain controls it with a little lever on the bridge. With a bow propeller the *Canberra* will need fewer tugs, or can dock without them. For passengers, it will permit much faster docking and leaving the dock.

Opening the Pacific

The *Canberra,* plus the *Oriana,* which went into service in 1960, mean that the Pacific ocean may be opening up for sea travellers as the Atlantic did several generations ago. Matson, American President Lines, and P. & O.-Orient are now in the act; Japanese companies are planning new vessels to compete. Soon the Pacific will be crisscrossed as never before by big, fast, luxurious ships.

All of this shows the thinking of many major steamship lines in 1961: that, in spite of jet planes and a sharp increase in air travel, the golden age of travel by luxury ship may be just beginning — not over and done with, as some experts would have us believe.

Actually, there is some evidence that the optimists among the ship men may be right although the report of the Shipbuilders Council of America, released in April, shows that the passenger ship fleet of the United States has declined to a total of only forty-eight craft, having a total capacity of 18,042 passengers.

However, on the other side of the ledger, the spring flow of ship travelers to Europe from American ports was higher in mid-April than in any similar period since the end of World War II. Cruises, including around the world, were never more popular, despite some cancellations to the American tropics because of the Cuban situation.

Oceanography and the marine sciences will continue to play important roles as more knowledge of sea currents, oceanic weather conditions, etc., is made available to mariners and ship operators. Combined with new ships, engineered for sea-kindliness, there may well come about a world-wide increase in sea voyaging. The claim of the airlines that they get you to your destination quicker, has been countered by one famous steamship company: "Getting there is half the fun." How much the "fun" will be aided and abetted by science and engineering now rests in the hands of the jury — the sea passengers themselves.

WATER, BASIC ELEMENT *of marine research, envelops the U. S. Biological Laboratory, Beaufort, North Carolina. At the right center are the buildings of Duke Marine Laboratory, and, at the left, the town of Beaufort. Across the skyline runs Shackleford Banks, one of a series of thin islands which protect the coast of North Carolina from the open Atlantic. (U. S. Bureau of Commercial Fisheries)*

At Hatteras' Back Door

By G. B. TALBOT

U. S. Biological Laboratory, Beaufort, North Carolina

WHEN SIR WALTER RALEIGH'S expedition reached the shores of North Carolina in 1584, its adventurers were chiefly interested in finding gold or other precious objects. Abundant sea food was duly noted, however, and was a determining factor in establishing a colony in "Virginia," as the area was then called. The first colonists arrived in 1585, others in 1587, and settled on Roanoke Island, at the northern end of Pamlico Sound. Marine life formed a staple part of their diet.

"Lost Colony"

However, a supply ship from England, in 1590, could not locate the

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colonists and to this day they have been referred to as the "Lost Colony." Nevertheless, recent studies indicate that the Roanoke settlers may not have vanished completely, but perhaps relocated on Cedar Island about seventy miles to the south.

Although the mystery of the "Lost Colony" has never been solved, and the discovery of valuable minerals did not materialize, the abundance of marine life in this area continues, and it played a dominant role in the settlement of tidewater North Carolina.

Varied Marine Areas

T. N. Gill and William Stimpson were the first scientists of note to recognize this area as suitable for marine research. Near Beaufort, which these zoologists visited in 1860, are large tidal estuaries; several rivers and creeks; extensive sounds of salt, brackish, and fresh water; marshes; cypress swamps; large offshore banks, as well as the ocean shore, with its expansive sandy beaches and broad dune areas.

In 1871-72, Elliot Coues and H. C. Yarrow, zoologists, visited Beaufort and further stimulated interest in the locality. They were followed in the next few years by professors and students from Johns Hopkins University, who maintained a small laboratory in Beaufort for about ten years.

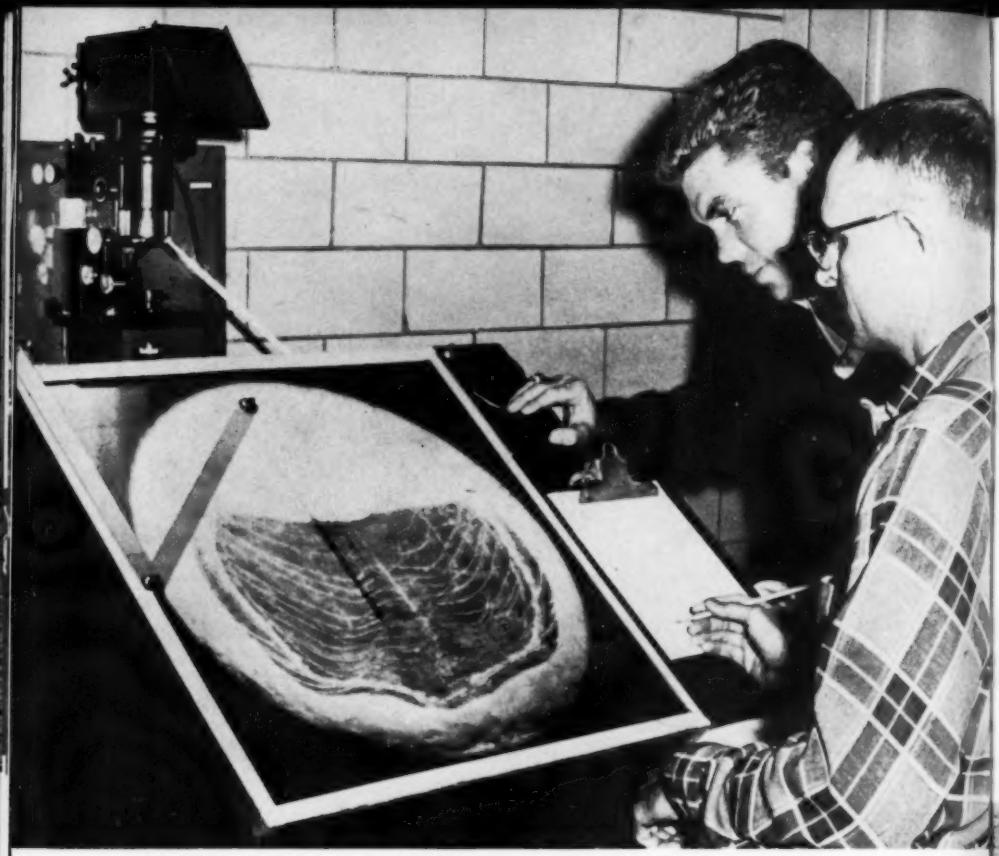
Cutting Red Tape

An act of Congress, approved May 12, 1900, authorized the U. S. Fish Commission to establish a biological station and laboratory in North Carolina. Through some oversight, however, funds were not provided for the purchase of land. At the suggestion of Professor I. A. Holmes, state geologist of North Carolina, this was not allowed to delay construction. About $400 was subscribed by several institutions—the University of North Carolina, the University of Virginia, Johns Hopkins University, South Carolina College and the University of Georgia for the purchase of a site. After careful investigation, Pivers Island, in Beaufort Harbor, was chosen. Work was begun immediately and a research laboratory and other buildings were completed in 1901.

Interrupted Only By Wars

Since that time marine research has been carried out by the Bureau of Commercial Fisheries at this station, known as the U. S. Biological Laboratory, except for brief interruptions during the two World Wars. Many of the most prominent biologists of our time have been associated with it. These include, among others, Brooks, Hildebrand, Grave, Wilson, Hopkins, Radcliff, Pearse, Mast, Hoyt and Hay. Their work laid a firm foundation upon which modern researchers can build.

TEMPERATURE AND LIGHT *are controlled in the room where the uptake of radioactive nutrients are determined. Here a test is being made on marine planktonic algae grown in enriched sea water. Fluorescent bulbs simulate daylight, while a refrigerating unit maintains a constant 68°F. (U. S. Bureau of Commercial Fisheries)*



AMERICAN SHAD SCALE, *enlarged 27½ times, reveals such secrets as age, number of times spawned, and age at first spawning. This specimen was obtained from the Connecticut River. (U. S. Bureau of Commercial Fisheries)*

Duke University established a marine laboratory adjacent to the Federal Station in 1938, and in 1947 the University of North Carolina founded the Institute of Fisheries Research in nearby Morehead City. The facilities of the three laboratories make this area an outstanding center for marine research.

In 1949 the Bureau of Commercial Fisheries began to modernize the station which had served so well for half a century. A new fishery laboratory to replace the 1901 wooden structure, a radiobiological laboratory, a dormitory, a maintenance building, a residence for the director, and concrete road and parking area have now been completed.

The new fishery laboratory, service building, dormitory, and residence are of masonry construction, well-suited to the Beaufort climate. The laboratory is a one-story building, 168 feet long by 32 feet wide.

A wing, 72 feet long and 32 feet wide, extends from the library at the

center of the building. This contains additional offices for the biological staff and allows full use of facilities by all staff members.

Protection from Radiation

The radiobiological laboratory is a one-story frame building, 77 feet long by 44 feet wide, with an adjoining wing. The building is divided into several laboratory rooms, containing special equipment for the various research in progress. Frame partitions separate the laboratory rooms, except where protection of instruments and workers from penetrating radiation is necessary. In these cases, 17-inch concrete walls extend from floor to ceiling.

Other research facilities at the U.S. Biological Laboratory include nine oval concrete pools supplied with salt and fresh water, each measuring approximately 96 square feet; two large concrete pools, approximately 30 by 40 feet, supplied with running sea water; a 30 by 40 foot fresh water pool; and a 30 by 80 foot tidal pen. These pools provide space for holding aquatic animals.

Laboratory Fleet

Two motor vessels are maintained at the station: a 40-foot cruiser equipped with a marine radio, galley and bunks for two; and a 26-foot V-bot-

TEDIOUS BUT NECESSARY FIELD WORK. *Raising the drag used to determine speed and direction of currents in the Newport River estuary. Such hydrographic studies help to determine causes for fluctuations in the abundance of blue crab populations. (U. S. Bureau of Commercial Fisheries)*

tom launch for daytime use. Outboard motor boats and trailers are also used.

Fishery research depends upon the needs of the commercial fisheries and special qualifications of the staff. At present, five major investigations are under way.

Research on American shad *(Alosa sapidissima)* of the Atlantic coast has been conducted since 1950 to determine the cause of the decline in abundance of this species, and to determine methods of stabilizing and increasing the yield. This can be done when the catch in a river, and the amount of gear used in making the catch each year, is known over a period of years.

Predicting Shad Runs

In the Hudson and Connecticut Rivers, where such data have been obtained, it was found that the number of fish allowed to spawn each year is the major factor in determining the size of shad runs. Mathematical equations now predict one year in advance the shad population that will enter the rivers. Fishing pressure can be regulated to allow the optimum number of spawners to produce maximum yields. In other words, it is now possible scientifically to manage these fish populations.

CRAB FLOATS, LINED WITH NYLON, *provide a means of checking the development of eggs of the yellowfin menhaden* (Brevoortia smithi). *Eggs and sperm are first obtained from ripe fish. The fertilized eggs are then placed in the floats, and fish are reared from eggs through larval stages. Specimens of these stages allow comparison and identification with plankton material taken from nets. (U. S. Bureau of Commercial Fisheries)*

Many facts concerning the life history of American shad were revealed during the study. Among these are the age of the fish, as well as the number of times it has previously spawned, by a method using scales from the fish. Perhaps the most interesting result, however, is the disclosure of the annual migration pattern of the species, involving a journey of over a thousand miles to the Gulf of Maine in the summer and back to the middle Atlantic region in the fall. This migration is made by immature as well as adult shad.

Crabs and Menhadens

Causes for the great fluctuations in abundance of blue crabs *(Callinectes sapidus)* are being sought at the laboratory. Research is concentrated in the south Atlantic States at present, but will be expanded into Chesapeake Bay when finances and adequate staff permit.

A third study involves Atlantic coast menhadens. Menhadens rank first *in volume* among all commercially caught fishes in the United States. Although not utilized as human food, menhaden are processed into meal, solubles and oil. While production is high at the present time, fluctuations in catches have occurred. The program will determine causes for these fluctuations, and the extent to which they are predictable.

Juveniles in Estuaries

Menhaden spawn at sea, but the eggs and larvae are carried into estuaries where the young may remain for periods up to a year before returning to the ocean. Studies to date have shown that along the Atlantic Coast of the United States the Atlantic menhaden *(Brevoortia tyrannus)* is the major species of commercial importance. The yellow-fin menhaden *(B. smithi)* is the principal species south of Cape Canaveral, Florida, while a third species in Florida, similar or identical to *B. Patronus* of the Gulf of Mexico, is found in lesser abundance.

A study of the juveniles in the estuaries has shown the existence of at least two subpopulations of Atlantic menhaden—one occurring north of Long Island and another south of Long Island. Apparently, however, the two groups mix when they enter the ocean.

An age analysis has disclosed that while most menhaden are caught during the first three years of their lives, some are caught up to the age of ten years. Certain brood years of fish have been found to be extremely abundant and sustain the fishery for several years. It is hoped that research will disclose the cause or causes responsible for the great abundance of young produced in certain years. Trends in the catches of menhaden will be followed for several years. With this information and the biological data it is possible that menhaden populations and catches will be predictable in future years.

Fish of Many Names

Atlantic coast striped bass *(Roccus saxatilis)* are known by several names. In New England they are called "strip-ped bass" or more commonly just plain "bass," since to an avid

SEINING FOR YOUNG ATLANTIC MENHADEN. *Although it is not a food fish for man, the menhaden is a valuable food supplement for animals, and is one of the most abundant fishes in U. S. waters. Its early development, however, is dependent upon suitable conditions in bays, rivers, and estuaries. Hence such sampling by biologists shown here. (U. S. Bureau of Commercial Fisheries)*

striped bass sport fisherman there is only *one* bass. In Chesapeake Bay they are usually referred to as "rock" and elsewhere as "stripers" or "rockfish." This species is eagerly sought by both commercial and sport fishermen. Aim of research here is to maintain the present adequate supply of fish for both groups by proper conservation measures.

Striped bass up to 125 pounds have been caught and 50 to 60 pounders are not uncommon, but fish less than six pounds in weight constitute almost the entire commercial catch along the Atlantic coast. These fish usually confine themselves to specific sounds, bays, and rivers, although they may overflow from these areas to the New England coast. Recent tagging experiments show that six to fifty-pound "jumbo" stripers, found during the winter off the North Carolina coast, annually migrate into Chesapeake Bay in the spring and to New England waters in the summer.

More Water For Fish!

Research on North Carolina striped bass and on various aspects of its life history by the laboratory staff is playing a part in the licensing of a new power dam on the Roanoke River. This is expected to result in more waters for striped bass spawning there and helps to put the water demands of a spawning fish population on a par with those of industry.

One of the most important research projects is a joint effort of the Atomic Energy Commission and the Bureau of Commercial Fisheries to study the accumulation of radioisotopes by marine phytoplankton, invertebrates, and various species of fish. A radioisotope coming into contact with sea water will either go into solution or form particles. Which of these occurs to a particular radioisotope in atomic wastes will determine whether or not it enters into the metabolism of marine organisms. Many radioisotopes form particles that cannot be broken down in the digestive tract of animals. Thus they cannot pass through the lining of the digestive tract and enter into the metabolism of the organism.

How a Fish Becomes Radioactive

Concentrators of food elements, the microscopic plants or phytoplankton that drift in the upper layers of the water, accumulate most radioisotopes, and thus play an important role in passing them to marine animals. A large variety of animals feed on phytoplankton, including animal plankton (zooplankton), oysters and related animals, and some species of fish. These animals have straining devices which they use to filter the phytoplankton from large volumes of water.

Radioisotopes contained in the phytoplankton when eaten may enter into the life chemistry of these animals and be concentrated to considerably high levels in their bodies. The zooplankton are large enough to be eaten by young fish, and in some instances by adult fish, and may be a means by which certain radioisotopes enter the body of fish.

Radioactive Danger

All radioisotopes, however, do not necessarily pass through a number of smaller animals before reaching large fish. Some radioisotopes can be taken directly from the water by an animal anywhere within the food-web. Since elements within a plant or animal are in a dynamic state, continually entering and leaving, a radioactive plant or animal will eventually lose most of its radioactivity if kept in non-radioactive sea water.

This investigation provides data necessary for proper waste disposal practices, and for the safe operation of nuclear-powered ships in coastal areas. The information is also valuable in the development of monitoring programs, designed to detect and evaluate hazards from normal or accidental pollution of inshore waters and marine resources by radioactive materials.

State Cooperation Important

In addition to research activities, the Branch of Statistics of the Bureau of Commercial Fisheries maintains offices at the laboratory. Fisheries statistics on catch, gear, boats, and fishermen are compiled for North Carolina, South Carolina, and Georgia, with the cooperation of state agencies. Since management research depends upon fishery statistics, this service is of considerable help to most of the research projects undertaken at the laboratory.

During recent years the value of

North Carolina's fishery resources alone has exceeded eight million dollars per year. Fishery products along the whole Atlantic and Gulf coasts amount to over three million tons, valued at $225 million annually. Thus, it can be seen that while Sir Walter Raleigh and his colonists hoped for gold, their early efforts led to the discovery of a much greater and more valuable resource in the fisheries.

Furthermore, this is a renewable resource which, if properly conserved, can continue to produce annually, rather than being exhausted as in the case of mineral deposits. It is the function of the U. S. Biological Laboratory, as part of the Bureau of Commercial Fisheries working with state and other conservation agencies, to help the fishing industry by giving, among other things, assistance in research and resource management to assure sustained production of this most valuable national resource.

TAGS REVEAL FISH *wanderings. Tagging a "jumbo" striped bass along the North Carolina coast is a two-man job, and little wonder when this specimen tipped the scales at 47 pounds and was over 42 inches long. Tag returns have shown that these large fish winter along the North Carolina coast, spawn predominately in Chesapeake Bay streams, then migrate northward, spending the summer off Massachusetts and Rhode Island. (U. S. Bureau of Commercial Fisheries)*

ADDITIONS TO THE INSTITUTE OF MARINE SCIENCE. *New dormitory (rear) offers modern efficiency apartments for visiting scientists and research scholars. The windowless structure in the foreground is a refrigerated building for the storage of deep-sea cores until they can be studied by laboratory technicians. In the background (right) rises the Golden Aquadome of the Miami Seaquarium. (E. John Long)*

Institute of Marine Science

Expansion of program and research facilities has necessitated a change in the name of a famous division of the University of Miami. It is no longer "The Marine Laboratory" but the "Institute of Marine Science."

Established as a part of the University of Miami in the winter of 1942, the Marine Laboratory was a one-room institution founded in response to the need for a tropical marine station readily accessible to the educational and scientific centers of continental United States.

Its founder, Dr. F. G. Walton Smith, continues as its Director. The marine station has grown to a full-fledged research and scientific publishing center, employing about 200 scientists and others, and contained in its own 7½ acre campus on Virginia Key, Miami. Five modern buildings house its laboratories, business and publishing offices, and, in addition, there is a new dormitory for the use of visiting scientists and research workers.

The overall name "Marine Laboratory" has not, for some time, been

an accurate designation of its expanded operations, which include a Graduate Teaching School, the Gulf and Caribbean Fisheries Institute, fishery management studies, physical as well as biological sciences (oceanography, marine geology, meteorology), and the publication of the *Bulletin of Marine Science of the Gulf and Caribbean.*

The station also houses divisions of the U.S. Fish and Wildlife Service, Department of the Interior, and an office for the International Oceanographic Foundation, publishers of *Sea Frontiers* and *Sea Secrets.*

Future plans call for more new laboratory buildings, a Marine Science Museum, a 750-ton ship and a 1,500-ton vessel, both especially designed for oceanic research work. While it is difficult to make a direct comparison, the Institute of Marine Science of the University of Miami is now believed to be the third largest station of its kind, being exceeded in size and personnel only by the Woods Hole Oceanographic Institution, at Woods Hole, Mass., and by the Scripps Institute of Oceanography at La Jolla, Calif.

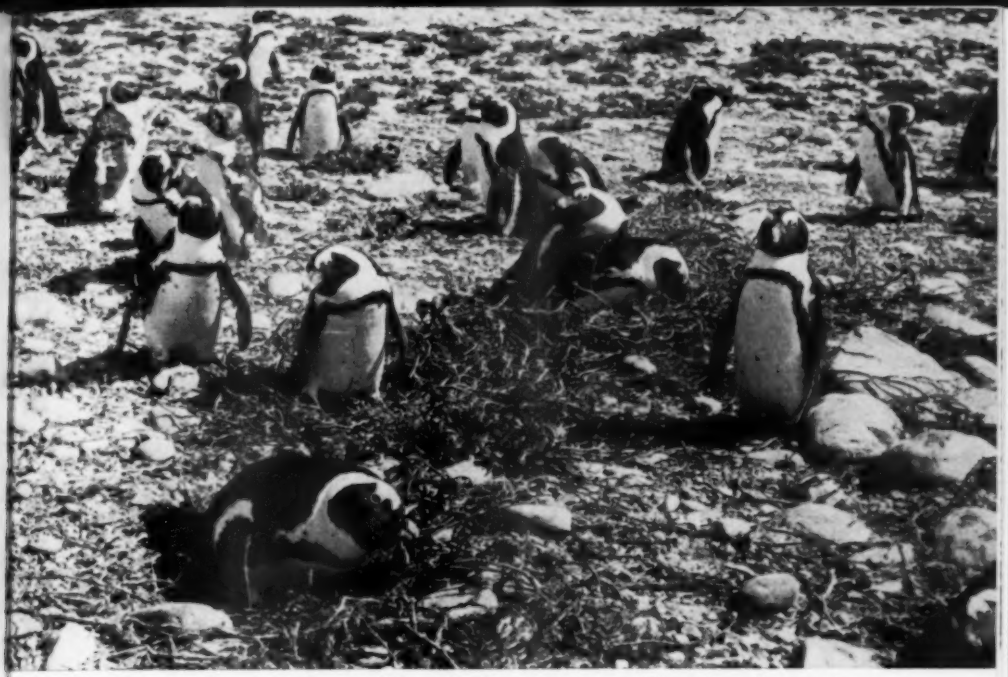
Ghost Nets Haunt the Seas

"Ghost" nets that go on fishing, years after they have been lost at sea, are presenting a novel problem of fish destruction in many parts of the world, especially in the heavily-fished waters around Iceland.

The gear in Icelandic waters is the bottom-set cod gill-net, made of non-rotting synthetic fibers. Such nets are fitted with metal or plastic floats which, like the nets themselves, do not rot. When the nets are lost by fishermen, they are maintained in a fishing position by the floats, and nets accidentally retrieved months or years after they were lost are found to contain great quantities of rotten fish and fish bones as well as live fish.

The Food and Agriculture Organization (FAO) Fisheries Division at Rome is investigating the problem, not as a present serious threat to any fishery but as a potential threat to the heavily fished Icelandic waters. Suggestions for solving the problem include one proposal that the floats of nets should be attached with untreated cotton which would quickly rot away if the nets are lost. Released from the floats, the nets would sink to the bottom and cease to catch fish. Float lashings of this type would have to be renewed periodically, making extra work for the fishermen.

Both the International Council for the Exploration of the Sea and the International Commission for the Northwest Atlantic Fisheries will continue to work toward a practical solution, since the extensive use of synthetic fiber nets requires that effective action be taken.



MENACE TO SOUTH AFRICAN *fisheries? The Jackass or Black-footed penguin, which inhabits eight islands off the coast of Cape Province, has recently been the subject of a special study made by the Union of South Africa. (Division of Fisheries, Union of South Africa)*

Penguins as Fish Eaters

Everyone knows that the penguin, of whatever species, lives on seafood, but how much it consumes, and whether it can be considered a competitor of man for the largess of the seas, has been largely guesswork.

Now comes a report from the Department of Commerce and Industries, Union of South Africa, summarizing an interesting study of the feeding habits of the Cape (Jackass or Black-footed) penguin, *Spheniscus demersus,* in waters which man fishes.

The report covers only a limited area off the Cape Peninsula and vicinity, but it throws new light on the penguin as a seafood consumer.

A new population count discloses that some 103,000 penguins are permanent residents of eight islands off the coast of southwestern Cape Province. Commercial fishing companies working the area were interested to learn that these 103,000 penguins, feeding about 185 days, consume an estimated 7,000 tons of marine food, of which 42 per cent (2900 tons) are fish of some economic importance. While this poses no immediate threat to the fishing industry of South Africa, it is a factor to be kept in mind as the population explosion of the world continues, and man must turn more and more to the sea to supplement his diet.

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The Diminishing Sturgeon

By BERNARD L. GORDON
Rhode Island College of Education

SOMETIMES man's activities can put an end to creatures which have survived millions of years of geological stress. For example, the sturgeon belongs to a primitive group of fishes dating back 300,000,000 years to the Devonian period. But, in spite of its long ancestry, and although once very plentiful in North American waters, it has shown a great decline in recent years.

In ancient Rome it was accorded a high place from the earliest days of the republic down to the times of Vespasian. The sturgeon alone was reserved the high honor of being served at a banquet to the music of flutes and pipes, crowned in flowers and carried by slaves likewise crowned. Cicero makes at least four references to it and states: "Lo! this is a fish fit only for a few choice palates."

A Kingly Dish

King Edward II of England, who assumed the throne in 1307, took a great liking to this fish and issued the following edict: "The King shall have the wreck of the sea throughout the realm, whales and great sturgeons." At one time any sturgeon captured above the London Bridge belonged to the Lord Mayor of London and all others to the King because of royal decree. King Henry I is said to have banned the eating of sturgeon at any table except his own.

Early colonists to America marveled at the abundance of sturgeon in the rivers. An old report states: "In some rivers of Virginia, sturgeon are found in such numbers that six hundred have been taken in two days with no more trouble than putting down a pole with a hook at one end to the bottom and drawing it up again on feeling it rub against a fish."

During colonial times in New England, pickled sturgeon was an important article of commerce and considerable quantities were exported to the West Indies. In 1629, Governor Endicott of the Massachusetts Bay Colony was ordered to send home to the company in London two or three hundred firkins of sturgeon and other fish. By 1633, a considerable export trade existed in pickled sturgeon, most of which was caught in the Merrimac River. The term pickling refers to the process of boiling the meat and preserving it in weak vinegar flavored with suitable spices.

A STURGEON VIEWED *from the underside might be a Halloween mask or a man from outer space. What look like eyes are really gill openings but the mouth is actually a mouth. "Chin whiskers" are short sensory barbels, which aid the fish in searching for food in muddy waters where its eyes are of little use. (United Press International and Miami Seaquarium)*

WITH BILLOWING SAILS *as graceful as a gull's wings, this Black Sea fishing boat seeks sturgeon, the source of the world-famous delicacy, caviar, off the coast of Romania. The largest sturgeons on record have been caught in the Volga and Dnieper Rivers, and in the Caspian and Black seas. (Fawcett Publications)*

In the early 1700's there was a flourishing sturgeon fishery in Maine on the Kennebec. Many thousands of kegs of cured sturgeon were put up in a season and they were declared as good as any that came from Hamburg or Norway.

Oil Used in Lamps

During 1841, Mr. N. K. Lombard, representing a Boston fish firm, came to the Kennebec and set himself up in the sturgeon business in the town of Woolwich, between Bath and Merrymeeting Bay. He proposed to put up the roe for caviar and also boil down the bodies for oil. He paid 25 to 50 cents apiece for the fish and a large number of local fishermen became engaged in sturgeon fishing. An old record states that during the first year Lombard obtained 160 tons of sturgeon, which yielded a lamp oil said to be superior to sperm whale oil. This fishery appears to have flourished until 1851, a year in which the species became scarce.

The name sturgeon seems to have originated with the Anglo-Saxon *stiriga* meaning a stirrer, the Swedish *stora* to stir or the German verb *storen,* which means to poke or rummage around, which the fish does on the bottom. In very old books we find this species referred to as storgin or sturjourn.

Seven Species in American Waters

The sturgeons include about fifteen species found in the Northern Hemi-

sphere, seven of which occur in American waters. The most abundant species on our East Coast is the common sturgeon *Acipenser sturio,* found from the Saint Lawrence River to the Gulf of Mexico. A second species, less abundant and smaller, is the short-nosed sturgeon, *Acipenser brevirostris,* recorded from Provincetown, Massachusetts, to Charleston, South Carolina.

Sturgeon hold the lofty position of being also the largest species of fresh water fish. In the United States, a record sturgeon was recorded from the West Coast which was eighteen feet long. A white sturgeon (*Acipenser transmontanus*) taken at Astoria, Oregon, weighed 1,900 pounds. What is probably the largest sturgeon on record is a Beluga or Russian sturgeon, *Acipenser huso,* which weighed 3,210 pounds.

Source of Best Caviar

The Beluga, which makes the best quality caviar, are found in the Volga and Dnieper Rivers, and the Caspian and Black Seas. Many Russian sturgeons weighing over a ton have been recorded. One 2,680-pound female contained over 320 pounds of eggs, enough to make canapes for a regiment.

Most species of sturgeon are found both in salt and fresh water. They spend much of their adult life in the sea and enter the rivers only for spawning purposes like shad and salmon. In some of the rivers and lakes

GOURMET'S DELIGHT. *Canada's fragile sturgeon eggs, which find a ready market in the United States, are gently packed in four-ounce jars in a northern Ontario caviar plant. A mature female sturgeon may produce as many as two to three million eggs during a single breeding period. A fine mesh screen is here being used to separate the roe or eggs from enveloping membranes. (Wide World Photos)*

of North America and Europe, certain species of sturgeon have become permanent residents of fresh water. The largest species are among these.

Still Caught in Otter Trawls

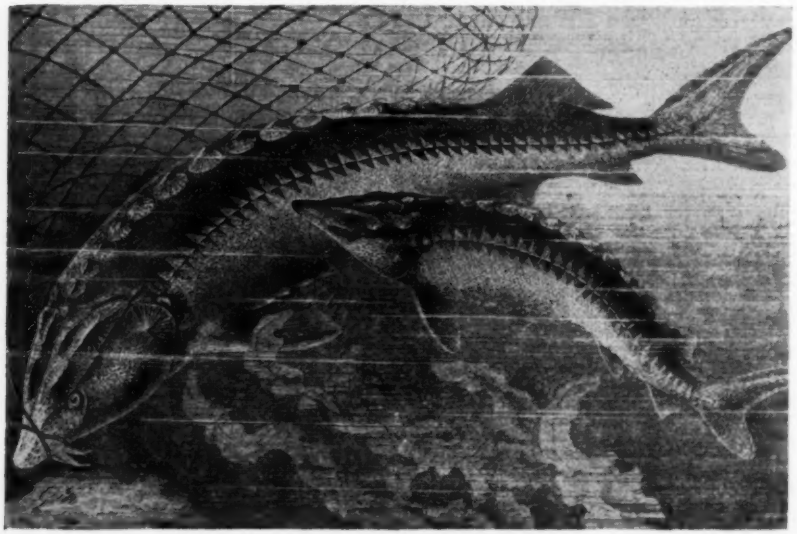
Off the New England coast, fishing draggers occasionally capture sturgeon in their otter trawls. One of the most notable catches (recorded by Bigelow and Schroeder) was a common sturgeon (*Acipenser sturio*) weighing 600 pounds, which was caught by the steam trawler *Fabia,* on George's Bank, in December, 1932. In the winter of 1954, the trawler *Phantom* landed a 374 pound sturgeon at Boston. It was taken thirty-five miles off Cape Breton Island, Nova Scotia. Numerous smaller sturgeon are caught each year by trap fishermen and draggermen.

In 1954, only 517,000 pounds of sturgeon were landed by United States fishermen. This figure is a far cry from the turn of the century when the sturgeon catch of the Delaware River alone totaled 5,023,175 pounds. In 1899, the sturgeon yield of the Great Lakes totaled 1,129,348 pounds of fish.

Why the Decline?

The decline of these great fisheries can be traced to two chief factors, overfishing and pollution. At the beginning of this century there were no conservation measures, such as size limits regulating the fishery and it was soon exploited to the utmost. Indus-

BECAUSE THE STURGEON *has a long, pointed snout, it is easily caught in gill nets, as well as otter trawls. Note the formidable, armor-plated body. At the end of the tail the caudal fin resembles that of a shark. (Wood cut from author)*



trialization along the Great Lakes and coastal rivers created waste pollution which made vast stretches of water unsuitable for reproduction of the species. Being unable to carry on normal reproduction, the sturgeons diminished.

Armor Plated Body

Sturgeons are formidable looking, with closely sutured scales or bony plates on the head and body. There are five distinct rows of these bony plates or scutes along the sides of the fish. The sharp-edged plates along the muscular tail make them a considerable menace to fishermen handling those freshly caught. These plates have been known to cut a man's leg to the bone. At the end of the tail the caudal fin resembles that of a shark.

The mouth is rounded and small, being found on the underside of the head. The sturgeon has the unusual ability to pucker its mouth and protrude it out from the body when it wants to suck in a choice morsel of food. This funnel-like mouth is thrust downward by a forward or backward swing of the suspensory bones of the hyoid arch. The mouth is also unique in all forms in that it is toothless in all stages except the larval forms.

Immediately in front of the mouth, arranged in a transverse row, are four short sensory barbels, which aid the fish in searching for food in muddy waters where its eyes are of little use. The eyes and respiratory spiracles are relatively small and found on the sides of the snout.

The sturgeon is usually a slow-moving creature rooting in the mud and muck for small organisms which it draws up into its protruding mouth. Its diet consists chiefly of worms, mollusks, crustaceans, aquatic plants and small fishes. On rare occasions sturgeon have been known to leap clear out of the water.

Being anadromous, like salmon and shad, the sturgeon enter coastal rivers in the late spring on their spawning migration. During the early summer months, the female forces out her eggs by rubbing her belly over rocks, submerged stumps and other firm objects. A mature female may produce as many as two or three million eggs during a single breeding period.

The ripe eggs are blackish in color and each egg is enclosed in a sticky, gelatinous envelope which causes it to adhere to nearby objects. Sometimes the eggs clump together in a large dark mass. The eggs usually hatch in three to seven days, and the larvae when they emerge are less than one-half inch in length.

Roe Relished by Gourmets

The roe from ripe sturgeon is relished around the world by gourmets. To prepare the expensive caviar, the fresh roe is placed in large masses on a small-meshed screen. The processor gently rubs the mass of eggs back and forth over the screen, separating the eggs from the enveloping membranes.

The eggs are washed in vinegar or white wine, and afterward spread out. The best quality Luneburg salt is then rubbed in well by hand. After adding the salt, the eggs at first become dry, but in ten to fifteen minutes the salt

has drawn from the eggs their watery constituents by osmosis and a copious brine is formed which is poured off. The salted eggs are then poured into very fine mesh sieves, which hold about ten pounds each, and allowed to drain for eight to twenty hours. They are then packed in oaken kegs or cans for market as caviar.

Caviar Not a Russian Word

The word caviar is not of Russian origin but comes from either the Turkish word *Khavyah* or the Italian *caviale* and applies only to the sturgeon eggs after they have been salted. There is a so-called red caviar, which is not a true caviar, but really salmon eggs.

The majority of the caviar served in American restaurants today comes from the Caspian Sea region inside the U.S.S.R. Russian caviar occurs in three sizes. "Beluga" is the largest and best quality, coming from fish weighing up to a ton or more. A medium-sized caviar called "osetra" is taken from fish weighing up to 300 pounds. The smallest size, "sevruga," is from sturgeon under 150 pounds.

The best caviar is generally made in the winter months and must be refrigerated at a temperature of from 41 to 46 degrees centigrade or it will spoil. The difficulty in preparation and transport along with its unique flavor has made caviar an expensive delicacy around the world.

"Caviare to the General"

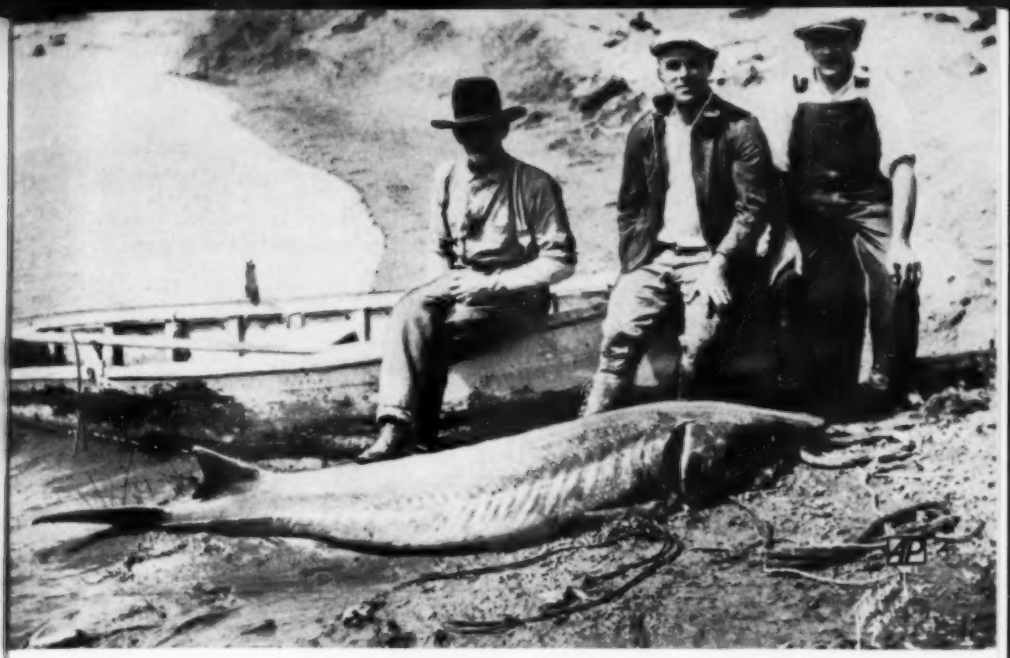
It has been known in Western Europe since the 16th Century, as Shakespeare's Hamlet states: "His play . . . 'twas caviare to the general." Caviar is best appreciated as an hors d'oeuvre with dry champagne, kummel or vodka. A coarse quality caviar, strongly salted in brine and known as *pajusnaya,* forms a staple article of food in many parts of the Soviet Union.

One product of the sturgeon, formerly of considerable trade importance, was made from the air bladder or sounds, a membranous sac which develops off of the pharynx. As early as 1525, Dutchmen produced semi-transparent, plastic-like sheets from these air bladders, calling them *huisenblas,* which literally means sturgeon's bladder. Users of this material came to call it isinglass, which was a little easier for non-Dutchmen to pronounce.

Source of Isinglass

In the preparation of isinglass, the air bladders are split open, thoroughly washed to remove the blood and membranous tissue, and spread out to dry on wooden boards. The silvery white inner lining, which is nearly pure gelatin, is then stripped off and, after being specially treated, is dried to form the commercial product. Common forms of Russian isinglass are long staple, short staple, leaf book and cake. Book isinglass is prepared by folding the sounds and then covering them with a damp cloth.

Today, the most important use of isinglass is in the clarification of wines, particularly white wines. Formerly used as a fining agent for beer, it has been superseded by more modern filtration methods. A single ounce of isinglass will usually clarify from



LARGEST OF FRESH WATER FISH, *sturgeon spend much of their lives in the sea, but enter rivers for spawning, like shad and salmon. In North America and Europe, however, certain species of sturgeon are permanent residents of fresh water. This eight-footer, hauled in by these three fishermen, was caught in Idaho's Snake River. (Wide World Photos)*

200 to 300 gallons of wine in eight to ten days. Isinglass was formerly used in the preparation of edible jellies, but high grade gelatines have taken its place. Isinglass is still used to a limited extent in the manufacture of court plaster, special cements and certain waterproofing compounds.

Magic In Cooking It!

The flesh of the sturgeon is firm but somewhat coarse compared to filet of sole or trout. Much depends on the nature of preparation, the cooking, and accompanying sauces. One gastronomic authority has stated that an experienced cook can turn sturgeon meat into beef, mutton, pork or poultry, with the proper culinary techniques!

Perhaps, with increasing interest in marine science and national means of managing our salt-water resources, such versatile products as these of the sturgeon may be kept from vanishing utterly. After surviving 300 million years of violent geogical and climatic changes it would be a pity for this group of fishes to succumb to careless exploitation by man.

Science of the Sea in BOOKS

Technical Reading

BEACHES AND COASTS

CUCHLAINE A. M. KING, St. Martin's Press and Edward Arnold Ltd., London. 1959 (Publishers). 403 pages; illustrations, graphs and tables. $14.50.

There long has been a real need for a single source book which could summarize the vast amount of literature printed on this subject since the publication of D. W. Johnson's book on *Shore Processes and Shoreline Development*, in 1919.

Beaches and Coasts appears to fill the need. Miss King's book departs from the usual descriptive procedures and devotes a considerable part to the dynamics involved in beach and coastal processes. The general and the specific, the experimental and the natural cases are developed. The book systematically presents a picture of what beaches and coasts consist of, what forces and processes shape them, and how these processes operate.

The book has a number of small errors which might be attributed to the author's lack of familiarity with

SUCH FORBIDDING *coastlines, where landings and exploration are extremely difficult, provide happy hunting grounds for the scientist. This one, on a remote Pacific isle, is volcanic in origin and is comparatively young, judging from the lack of erosion. (Smithsonian Institution)*

some geological literature. For example, on Page 3 the writer states that the phi-scale of size grading was proposed by Inman (1952) whereas, in fact, it was originated by Krumbein (1934). Similar errors might have been avoided had the author consulted a geological source, such as Pettijohn's book on *Sedimentary Rocks* (1949, 1957 2nd ed.). Indeed, the entire discussion of sedimentary parameters could have profited by referring to the chapter on "Texture" in Pettijohn's book.

Several major works seem to have been missed in the list of references, in particular, the book by Zencovich on *Dynamics and Morphology of Sea Coasts* (V. P. Zencovich, 1946, *Dynamika i Morphologiia Morskikh Beregov*, in Russian). The Beach Erosion Board's publication *Shore Protection Planning and Design*, Technical Report No. 4, 1954, and its *Corrections, Revisions, and Addenda for Technical Report No. 4, Shore Protection Planning and Design*, August, 1957, certainly should have been included.

On the whole, *Beaches and Coasts* represents a worthy attempt to assemble data about a complicated subject, consisting of many published papers. The book forms a valuable addition to the library of every serious student of beaches and coasts whether geographer, geomorphologist, coastal engineer, or geologist.

G.A.R.

HYDRODYNAMICS OF OCEANS AND ATMOSPHERES

CARL ECKART, Pergamon Press, New York. 1960. 290 pp. $9.00.

Pergamon Press must be congratulated on their endeavor to publish books dealing with advanced theories. Scientists will certainly welcome this book, which finally makes all the articles by Carl Eckart accessible in a single volume and unifies them by a general treatment.

The solution of the basic equation of thermodynamics and hydrodynamics is sought by the application of the perturbation method. In order to do so, only the zero and first-order quantities are investigated and the latter replaced by fields leading to three field equations which can be solved, since they are dealt with as generalizations of the wave equation. We are still far away from the general solution, but Eckart's masterly exposition of his general theory may excite other mathematical physicists to continue and approach the difficult task and to consider also the second-order quantities, which may finally allow us to describe the dynamics of the ocean and atmosphere in a mathematically strict form.

F.F.K.

General Reading

THE EDDYSTONE LIGHT

FRED MAJDALANY. Houghton Mifflin Company, Boston; The Riverside Press, Cambridge. 1960. 207 pages; illustrations and maps. $4.00.

Exciting and informative, this book should have a special place in everybody's library. Reading it, one marvels at the raw courage and resourcefulness of the men who struggled for many years against the forces of the winds, storms and sea so that Eddystone lighthouse might cast its cheery gleam, warning seamen of one of England's most dangerous rocky reefs. The first Eddystone lighthouse, built in 1698, went to pieces five years later during a storm described as the most vicious ever to hit England. The builder, Henry Winstanley, had expressed a desire to be in the lighthouse during a big storm. By purest chance, he did happen to be there when the

great storm hit, and he died as he had lived, with a flourish, taking his greatest work with him.

The second Eddystone light, built by John Rudyerd, lasted for a half century. It went down due to a combination of fire and storm. The third lighthouse, by John Smeaton, in 1759, did not go down, but the sea undermined the rock on which it was built. So it was replaced in 1882 by the present Eddystone light. Readers of this book may be convinced that the defeat of the Spanish Armada was child's play compared with building Eddystone.

E. R.

THE SALT-WATER AQUARIUM IN THE HOME

ROBERT P. L. STRAUGHAN. A. S. Barnes & Co., New York, 1959. 256 pp, index, 118 illustrations, 2 color plates. $7.50.

Judging from the number of inquiries received by the Foundation, the average aquarium hobbyist finds great difficulty in maintaining a salt-water aquarium. Mr. Straughan's book should go far towards explaining the proper way to go about this. It is well illustrated and clearly written and is recommended to all who desire to raise saltwater fishes or other marine life in home aquaria. F.G.W.S.

JOHN PAUL JONES

SAMUEL ELIOT MORISON. Little, Brown & Company. 1959. 453 pages. Illustrated. Index. $6.50.

With the possible exception of Lord Nelson, no character in naval history has been the subject of so much romance, controversy and plain balderdash as has John Paul Jones. The author, aware of this as he admits in the preface of this "sailor's biography," plunges boldly into his subject and manages to come up with some interesting material which, if not completely new, at least does much toward clarifying the record. Jones, for instance, never held a higher rank than Captain in the American Navy, but he achieved Admiral in the Russian fleet of Catherine the Great. His *amors* in Paris the author completely sorts out for the first time. Of the scrapes he got into in the West Indies, and which were to change the course of his life, Jones told that story only once, and then in confidence to Benjamin Franklin.

Mariners and yachtsmen will be particularly interested in a fascinating chapter, where Admiral Morison, himself a skilled sailor, digresses to describe in some detail the complicated handling of a square-rigged man-of-war, including the salty orders shouted by officers to the men on deck and in the rigging.

Unlike most historians, Admiral Morison apparently has insisted upon a fair measure of illustrations, including sketches, maps, and reproductions of contemporary paintings and sculpture. These add greatly to the pleasure of reading this engrossing biography of a tough, skillful sea fighter, who played a unique role in the American Revolution. E.J.L.

HIGH JUNGLES AND LOW

ARCHIE CARR. University of Florida Press, Gainesville, 1953. 226 pages. $4.50.

This book is of marine biological interest chiefly because of its brief, nontechnical account of the fishes of Lake Nicaragua, originally part of a saltwater connection between the Atlantic and Pacific Oceans. The fishes include a man-eating shark (close to *Carcharhinus leucas*) which reputedly attacks at least one person each year, abundant tarpon, a sowfish weighing up to seven hundred pounds, and eighteen species of cichlid fishes, all but one of which are found nowhere else in the world.

J.K.M.

About the Authors

GERALD B. TALBOT

Although he was born in the inland Canadian province of Alberta, Mr. Talbot's family soon moved to Tacoma, on Washington's Puget Sound, where he had his first acquaintance with ships and the sea. Later he studied fisheries at the University of Washington, and worked on problems concerning the sockeye salmon of the Fraser River for the International Pacific Salmon Fisheries Commission. He was associated also with experiments for the University of Washington's Applied Fisheries Laboratory, concerning X-ray damage to animal tissues.

In 1950 he joined the staff of the U. S. Bureau of Commercial Fisheries Biological Laboratory at Beaufort, N.C., and, since 1952, has been its director. During a leave of absence in 1958, Mr. Talbot assisted the government of Pakistan in its research on hilsa (an Indian shad), and surveyed facilities for possible coordination of research on hilsa between Pakistan, India and Burma.

ARNOLD B. JOSEPH

An engineer with the Atomic Energy Commission, Mr. Joseph's principal duties are concerned with the prevention of possible pollution of marine areas by radioactive wastes. The surveys described in "Operation Drum Drop" were carried out for his office, and he was aboard the *Gilbert* for the underwater studies. Mr. Joseph is a Vanderbilt University graduate and holds a Master's degree in Sanitary Engineering from Johns Hopkins University. In his spare time, which now is very little, he runs his 45-acre farm at Mt. Airy, not far from the new A.E.C. headquarters, at Germantown, Md.

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PRINTED BY PARKER, CORAL GABLES, FLORIDA, U.S.A.